ALL ABOUT THE SOYA BEAN

IN AGRICULTURE, INDUSTRY AND COMMERCE

BY

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WITH AN

INTRODUCTORY CHAPTER

BY

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PREFACE

ONE day while with some friends in London someone happened on the subject of Soya Beans. Though several of those present had been in the Far East no one had more than a scant knowledge about the bean and it fell to me to do what I could to enlighten them. Then I was asked "Why don't you write a book about it, and tell the British Public what a fine useful plant it is?"

The enforced leisure of retirement seemed to indicate that something should be done. I therefore set about writing "The Romance of the Soya Bean" feeling that there might be ground for romance in the rise to prominence of this leguminous Cinderella from its lowly position to a higher place in our national List of Imports.

I had, however, to change the title for, unfortunately for romantic attraction (the web I set to catch my flies), the interest lies submerged in a sea of unexaggerated matter-of-fact statements and notes on the wonderful qualities of the soya bean.

I claim little originality: the work has lain in the direction of collating material based on my own observations in China and the practical experience of workers at the subject in other lands who have become aware of the benefits that can accrue from a wider knowledge and a more popular use of the bean.

During my years of service in the Far East, while resident in the British Legation in Peking, I

became impressed with the way the soya bean entered so largely into the life of the Chinese people, not only on account of its food value but also for its important by-products. Hence my interest in the bean, and a knowledge that whatever I wrote on the subject was backed by my personal experience of the reliability of this product.

Apart from the quite marked benefits of the soya bean as a food, there appears to be a wide opening for development of an extensive trade in this article, a fact that has been realized by other nations.

One of the phases of the recent depression showed itself in commercial reluctance to launch out into new channels of business and trade. This was of course only natural. The necessity for encouragement of initiative in the heavily taxed and somewhat lagging trade conditions through which we have passed was abundantly evident. In the soya bean there is great scope for development and a trade factor without, one ventures to think, a risk of retrogression or loss. For the bean is no new product.

In the chapter on its history I have shown that it has been in use, and not only in use but one of the mainstays of the Chinese and their livestock for several thousand years. Furthermore, the nations who have had the perspicacity to develop the soya bean in the very few years since its introduction to Europe and the United States have not, on the showing of plain statistics, regretted their action.

General trade conditions are now showing steady improvement; the wheel of fortune is turning.

The soya bean has its foot, if one might use the

metaphor, on the lower rungs of the ladder. Now would be the time to give it the impetus to take it to the top where, once established, it would always remain.

In the compilation of this monograph I have been shown kindness and courtesy by the Imperial Institute in compiling the Soya Bibliography and by the managers of oil mills and other companies concerned in the soya bean trade, who have been so good as to give me valuable information.

I am also grateful to the Officers of the United States Department of Agriculture who willingly sent me the Official Bulletins they issue for the guidance of their farming community. They responded to my queries with readiness and goodwill.

In China, Mr. Norman Shaw of the Chinese Maritime Customs Service wrote in 1910 an Intelligence Report which was the first comprehensive summary concerning the production of and trade in soya beans.

Dr. Horvath, a scientist of Russian birth, now resident in America, also published two monographs, "The Soya Bean as Russian Food" and "The Soya Bean Oil of China and its Manifold Uses."

From both of these reliable writers I learned much and gathered useful facts, most of which I have verified as far as I possibly could before incorporation in this book.

Mr. J. L. North, late Curator of the Royal Botanic Gardens, Regent's Park, London, was so

good as to report to me the progress he is making in conducting experimental growths of the bean. I have been fortunate in finding Mr. North willing not only to write the Introductory Chapter but to revise what I had written. His persistent and patient work in Economic Botany and in eliminating varieties of the bean that were unsuitable for cultivation in England has had its reward in the splendid crops that have been harvested at Boreham, Essex, for the past two years. He is acknowledged as the leading expert on British soya cultivation and his observations which are all based upon his own practical experience may be regarded as authoritative and authentic.

Messrs. Frank Fehr & Company, London, the well-known oil and oil cake importers kindly furnished me statistics of the trade and I am also indebted to two leading firms of food manufacturers, the Dietetic Foods, Ltd., and Soya Foods, Ltd., for recipes and information courteously placed at my disposal.

It is to the encouragement and good advice given me by Mr. H. Hamel Smith, City Editor of *Tropical Life*, that this book is now published and I owe him thanks for the view he expressed that there would be a public to read what I have written.

G. D. G.

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AUTHOR'S NOTE

IN his Introductory Chapter Mr. North recounts in a descriptive way all the trials and difficulties he came through before arriving at the stage of acclimatization of soya seeds in this country.

The sapient fact emerges that not only were field crops of the bean produced at Boreham in 1934 but that that success was repeated in 1935 and shows every prospect of being continued in 1936.

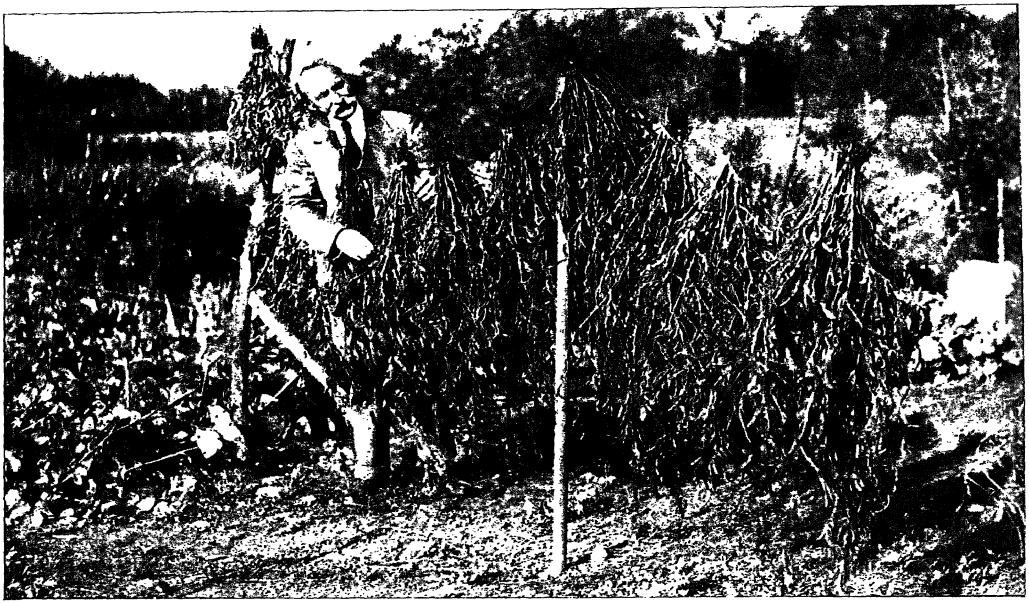
Let us hope that it will be so, for it will give further proof of British climatic and agricultural ability to produce what must be a very welcome addition to our list of national foodstuffs at a time when nutritional deficiency has become a prominent problem.

For many years to come we must look to Manchuria and, in lesser degree, to the U.S.A. for the supply of soya beans, cake and oil, but as for our food supply it is the earnest hope of the author of this book that he has shown the way to a new avenue of exploitation in this country.

If farmers find that they can produce a crop for which there is a good demand, many of the difficulties which Mr. North encountered will be overcome.

G. D. G.

Edinburgh, 1936.



Mr. J. L. North and soya bean plants which he has grown.

INTRODUCTORY CHAPTER

IT is with pleasure that I contribute a foreword to this very interesting and valuable work on the soya bean.

When I came to consider the most useful form it could take, I could not but feel that the best method would be to recount my experiences while engaged in the somewhat difficult task of trying to adapt soya for growth in this country as a crop plant. In some measure I have been successful but there is still much to be done before soya is accepted and generally cultivated on English farms. It is estimated that there are more than three thousand varieties of soya beans under cultivation in China and adjacent countries. Of these I have tested probably no more than two hundred. It is quite likely that in course of time better varieties will be found and introduced; but first they must be acclimatized and this is a long process. It has taken me twenty years to produce the four varieties now being grown. Out of more than two thousand sorts which have been introduced into the United States only about forty have proved commercially successful—proportionally the same as mine. In America acclimatizing is departmental work and it should be the same here; it is not work that should be done at the initiative and expense of private individuals.

In 1913 chance put in my hands thirteen small seeds of a variety of soya bean said to have come from North China in 1910 and to have ripened pods in Germany for two successive years. Sown by me

the following May the plants grew to a height of 1½ feet and ripened seed in October. This took place at the Gardens of the Royal Botanic Society, of which I was then Curator. I was aware that of the many attempts to grow soya which had taken place in this country, all had failed, also that no others were being attempted, since it was the considered opinion of the Ministry of Agriculture and of the Royal Agricultural Society that the soya bean was quite unsuited for growth here, as it required heat that would ripen maize.

The podded beans were brought to the notice of Professor Bottomley, of King's College, and Professor Greenish, of the Pharmaceutical Society, and both considered the matter to be important. They pointed out that this country possessed no oil plant and was importing soya from Manchuria to the extent of half a million tons per annum.

"If," they said, "we were able to grow the bean in this country not only should we save the money it was costing us, but British agriculture and trade alike would benefit." They advised me to increase my stock as rapidly as I could.

The result of the first year's crop was four hundred seeds from the original thirteen seeds; the second year four thousand, and the third twelve thousand. In 1917 it became a question of finding space to grow them and it was decided to have part grown by a firm of market growers at Uxbridge, Middlesex and the rest on a farm at Manningtree, Essex, belonging to Mr. C. P. Ogilvie. Both were failures. The first failed because the land had been manured at the rate of 60 tons per acre and was too

rich, also the seeds were sown too far apart. When I went to see them in September, I found a tangled mass of over-grown stems and leaves and no sign of pods. The second failure was due to rabbits. The seeds had been sown in the middle of a field of wheat. Visited in June, they appeared to be doing well. A fortnight later all had disappeared. I suggested to Mr. Ogilvie that rabbits were the probable cause.

"Ah," he replied, "if rabbits are fond of them you will find it difficult to grow soya beans in this country, for rabbits are like the poor, they are always with us."

Rabbits are still a trouble where soya is grown, but advances in combating this pest are steadily being made.

At that time little was known about the bean in this country; few books mentioned it; there was even less knowledge of Manchuria, the chief source of our supplies, and none at all about the Chinese methods of growing it. To gain experience, I sent seeds to the Chelsea Botanic Gardens, the Horticultural Society at Wisley, the Cambridge Botanic Gardens, Messrs. Sutton and Sons, Reading, and to a friend in Hampshire. But the reports received were not encouraging. That same year I got in touch with the United States Department of Agriculture at Washington, I received from it not only its soya bulletins and seeds of a number of American soya varieties for trial in England, but the promise of further assistance. I owe a very great debt of gratitude to that department and to Dr. W. J. Morse, its agronomist and soybean expert, the man who, more than any other, has

made the United States the soya bean centre of the world and now a growing competitor with Manchuria as world exporter.

The results of 1917 were rather better than those of the previous year and in 1918 I had sufficient seed of my one variety to plant half an acre on land lent by Mr. Clark at Virginia Water. These were sown in company with 12 American varieties, half being inoculated with a nodule culture supplied by Professor Bottomley; it was effective in producing nodules on the roots but at the end of the season I could find little or no difference between the dressed plants and those which had received nothing. It was not a good year, the ground was full of couch grass and required constant hoeing; rabbits attacked them and were only checked by spraying the plants with paraffin emulsion. I travelled up and down from London no less than 40 times during that season and in the end found myself with no more seed than I started with. Some of the American varieties made larger plants but none were as early as my own. 1919 and 1920 were poor years but 1921, the drought year, was the best I had had. Accounts of my success appeared in the Press and I wrote an article which came out in the *Illustrated London News* in October. As a result many applications for seed reached me and I sent the samples to over one hundred places, among others to Professor Southworth of Manitoba College, Winnipeg. He found my variety better than anything he had had there, both for fodder and seed, but not early enough in seasons with early frost. In return he sent me seed of a brown variety "Manitoba Brown," a selection

from a well-known American variety " Ogemaw."

The following year, 1922, proved very wet, especially towards the latter part, and of all those to whom I had sent seed not one reported success. It was the same at my own plot at Chiswick where I had 20 varieties under test. Only one, " Manitoba Brown," succeeded. In 1923 appeared Messrs. Piper and Morse's encyclopædic work, " The Soybean " in America; it solved a good many of my problems and I determined to follow American practice in future. From it I learned that two-thirds of the American crop was consumed as fodder upon the farm; that every variety had a fixed time ranging from 80 to 160 days for maturing; that in industry the chief value of the bean rested upon its oil content; and that the plant possessed what is now called " local limitations," meaning that a variety that grew well in one place could not be depended upon at another and that in American agricultural practice it was usual to test two or more varieties before growing it as a crop. This last was particularly interesting to me because it explained the erratic behaviour of some of my varieties when sent to other places.

Convinced by the failure of my 1922 trials that soya was not yet ready to put forward as a crop plant I extended my search for new sorts and with the help of friends abroad obtained many varieties from China, Manchuria, Japan, South Africa and India. As I had found by tests that owing to the different climate, growing in this country added 30 days to the normal time the same variety would require to mature in America, I began to specialize on short season varieties. My friend Dr. Morse approved

the plan and from then onward sent me only varieties which in America took less than one hundred days to mature. At that time I was testing from twelve to thirty kinds each year, all but one or two of them proving useless : the labour was great. With a smaller number I had more time and could give greater attention to selection. Using Manitoba Brown Soya as a standard I was able to select several varieties as early or even earlier than it. From these after long testing and selection of the best and most consistent " croppers " I obtained between 1924 and 1926 a yellow and black seeded variety and in 1930 a green seeded dwarf one. To these, following my usual practice of using letters to mark promising varieties, I gave the names C. J. O. and Jap—this last because it came from Japan. These are the varieties which are now being grown in England at the present time. The variety " A " with which I began in 1914 I grew until 1928. In fifteen years I had improved its cropping capacity from 20 to 80 pods per plant, but I could never " early " it and since it could not be depended upon in a wet season I had to give it up.

From 1922 to 1931 our summers were mostly cold and wet and my experiments had little success. A plot of two acres at Uckfield in 1924 was destroyed by rabbits from a near by copse. At this time the Ministry of Agriculture began to take an interest in soya and for several years sent its inspectors to visit my plots, but took no further action. The West Suffolk Education Committee in 1926 had seed of some of my varieties and grew them locally with fair success for several years. Imperial

Chemical Industries Agricultural Department also experimented with Brown C in 1929, obtaining with inoculated seed a fifty-fold crop in Berkshire that year. Messrs. Sutton and Sons of Reading in 1928 decided to grow the same variety and in 1930 put it in their catalogue. The first year they had not enough seed, the second, through defective drying, the crop gave only a 40% germination and the sale was discontinued.

In 1931, Mr. A. F. Secrett, a Twickenham market grower, offered the use of a piece of land at Brentford, Middlesex; it enabled me to grow on a larger scale than had been possible previously. In September the same year a photograph of the crop appeared in the *Evening News*. By chance it was seen by Sir John Davis, a Director of the Ford Motor Co. and Manager of the Ford Estate at Boreham, Essex, who at the request of Henry Ford had tried to grow soya with American seed and had failed. At his request I agreed to supply acclimatized seed and to superintend its growing. All my four varieties of soya were used and under field conditions the crop was a success. From 2 acres the first year it was increased to 12 acres in 1934 and to 20 in 1935, the last two crops being grown without assistance. The Boreham trials were visited by farmers from every part of the United Kingdom and visitors from America pronounced the crops to be as good as any grown in that country. The seed was distributed in 1935 and that year saw it being grown in quantity in some hundreds of places throughout the British Isles.

One of the chief difficulties in growing soya in

this country has been due to the difference in climate. In China and Manchuria—part of the Great Asiatic continent—there is a fixed succession of seasons with little variation from year to year. In this country, as a natural result of its being an island, variability is the rule; moreover, as the trend of the wind is mainly from the west, rainfall is unequally distributed, the western half getting double the amount that falls in the east of the country; also, in the west, the moisture-laden air from the Atlantic tends to lessen the amount and intensity of the sun's rays and shuts off a good part of its heat.

To a plant like the soya bean the change from a dry sunny climate to its opposite cannot be other than prejudicial; it has to remodel and fit itself to the new conditions or, in other words, it has to be acclimatized. In annual plants like soya, with a new generation every year, it does not take long to adapt itself to a new environment, the time taken varying according to the difference between new and old. Thus for some years to come it will doubtless be found to flourish better in sunny, dry East Anglia rather than the more humid western parts of our country, where conditions are most opposed to those of the country it came from.

That soya can be grown in this country the trials at Boreham and elsewhere during the last three years sufficiently prove: but at present market prices the margin of profit is too small to make British soya production a successful proposition. There is, of course, the possibility that prices will rise.

When the question of dropping the subsidy on sugar beet was debated in Parliament recently no

one suggested soya as a crop to replace it. Yet, as this book shows, it has fifty uses to the one of sugar beet. But before this question can be dealt with, the bean must be grown in quantity in this country and here we might with advantage follow America's example. For years before it was grown for seed, farmers of its Eastern States grew it as a fodder and hay crop for home consumption; they learned how to grow it, and when later it became more profitable to grow soya for seed it meant for them merely a change of varieties.

By growing it in this way our farmers would gain practical experience at little or no cost, cultivation on a large scale would naturally follow and Government assistance would not long be withheld.

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CHAPTER I

INTRODUCING THE SOYA BEAN.

Not generally known in this country — National Economic and Biologic differences — Mr. Sowerby's description of the bean—Edible soya products in China—The Chinese Labour Corps' good dentition—National dietetic customs — American and Oriental sources of supply—Japanese initiative — Manchuria, and Japanese participation in its development — American scientific encouragement—Successful production in England—Soya world-production—Benefits of growing our own crops.

IF one were to ask the average man-in-the-street about the soya bean his answer would be: "What is it? I have never heard of it." His response would be similar about many other exotic plants and commodities which loom large in the life of foreign nations but are still scarcely known among those of our people who have neither the opportunity nor occasion to travel.

There are many interesting features in the age-old civilization of the Far East.

The ordinary economic and biologic conditions of the Yellow Race differ largely from ours. Chinese and Japanese working men live much more cheaply than we can. Low wages are only possible where the cost of living is also low. Needs that can be satisfied at small cost make Oriental domestic life comparatively free from discontent. The Chinese do not drink milk nor do the majority ordinarily eat meat except on festive occasions, and

yet millions of them are by their diet able to accomplish a twelve hour day of hard toil, seven days a week, for what would be regarded in our country as an incredibly small wage.

The labourer has therefore to maintain his strength by nourishment which is cheap to buy and yet of sufficiently high caloric and energizing value to help him through his work with comfort.

And here lies the significance of the soya bean.

My friend, Mr. A. de C. Sowerby, Editor of *The China Journal*, and an acknowledged leading authority, in a note that he published on the properties of the bean, put the case tersely and well. He said :—

"The soya bean is unquestionably the most important individual food plant, and it is not too much to say that if the Chinese had it and nothing else their wants would be amply supplied. Fermented, it yields all their different sauces which supply the basic flavouring of their food; pressed, it gives out oil which can be used for cooking; sprouted, it gives a fresh vegetable rich in vitamins; plucked in the pod while still green, it makes a delicious table dish; ground dry, it forms flour from which bread can be made; ground wet and curdled, it provides the famous bean curd—a substitute for meat. Bean curd itself is treated in many ways to yield a variety of dishes. The soya bean also provides food for horses and cattle, while bean cake from which the oil has been expressed is an excellent fertilizer."

Having lived all his life in China, Mr. Sowerby has good grounds for his observations.

There is little, if any, change in the manner in which edible soya products are prepared for use.

Orientals find it to be a food that admirably answers their needs. The bean occupies a fixed place as the energizing constituent of their diet, which is otherwise composed of such cereals as millet, rice and corn with a few pickles and some piquant Soy sauce. It has remained unchanged for the past three thousand years and, owing to this regular dietary system, the Chinese have much greater freedom from dental and digestive troubles than is the case in England.

I was especially impressed with this during the Great War, when I held, for some time, a post which entailed the physical examination of large numbers of men in the Chinese Labour Corps, 100,000 strong.

On arrival in France, in 1917, the members of this Corps had to be individually overhauled before being drafted in Companies to serve in all the Camps where labour was required for our Army. In the course of this examining work I noted that it was the exception to find a man who had any bad teeth, just as it was rare to find a British soldier without a number of his teeth in a septic condition.

Our nationally bad dentition is due to faulty diet, and herein lies the advantage that the Chinese have in the simple and suitable nourishment provided by their use of vitamin-charged soya bean flour and curd.

One of the most startling revelations of the Great War was the considerable number of our C3 population. Since that period our increasing knowledge of vitamins and scientific feeding, and the spread throughout the country of welfare centres have resulted, as far as the lower, middle and artisan

classes are concerned, in a healthier race. But there is still room for the gaining of more knowledge; the age for guessing has been supplemented by the age for investigation.

It is said to be difficult to change the dietetic customs of a nation. In an issue of *Punch* there was an illustration of two working men in a public house. One of them says:—

"Ah tell thee, Joe, it's no good. T' Japs is getting t' world's markets because they can live on two-penn'orth of rice a day, but to thee and me rice, as grub, is about as much use as confetti."

In its own quaint way this is a very apt reflection of our national attitude.

If, however, we look into the matter more closely it will be found that there are plentiful evidences of change in our dietetic habits.

As late as the first half of the nineteenth century the ordinary Englishman began his day with a meal of bread and cheese washed down with small ale. In Scotland a big bowl of porridge was the staple dish. And have we not read of the amazing feats as trenchermen of our great-grandfathers. A man was not worthy of the name if he could not break his fast with a pigeon pie or two. But now, our breakfast table is laid out with products of world-wide source. Tea from India, coffee from Kenya or Brazil, bread from Canada and America, bacon and eggs from Denmark, butter from the Antipodes, and so on.

Our poorer classes eat meat to a much greater extent than they did three generations ago and much of it is chilled or frozen imported beef and mutton. At an average rate of 1s. per pound it is,

for them, a dear form of food. Then with regard to fruit, the increase in our fruit consuming habits of late has been phenomenal. At a reception given not long ago in Glasgow to a delegation of South American fruit growers the Lord Provost of that City stated that while ten years ago the annual import of Jaffa oranges was 10,000 cases, to-day it is 500,000 cases, and while the direct shipment of Australian fruit to Glasgow was non-existent four years ago, it amounted last year to 250,000 cases.

It would appear that our dietetic customs are not by any means immutable. Any prejudices there may be can be overcome by proper education of the consumer to the advantages to be gained from a new form of food.

A perusal of this book will show the wide range of articles than can be industrially made from by-products of the soya bean and when the chapter on its edible products comes to be considered it will be seen that the flour made by pulverizing the beans can be added to almost any conceivable preparation of food, increasing the nutritive value to a high degree because of the bean's richness in albumen.

In the United States of America there is no agricultural product that has increased so rapidly in the past decade as the soya plant which has a larger yield of beans than any known legume. But with a population nearly three times as great as ours, America consumes most of her soya harvest and limits her exportation of it to the comparatively small surplus that is extra to her domestic requirements.

We have therefore to look at the Orient as an important source of our supply. Manchuria is a land of great forests and immense rolling stretches of rich pastures. It has a remarkably fine climate with good rainfall and its general conditions are more favourable for Agriculture than in any other part of the Chinese Republic. Its total area is as great as that of France and Spain put together and one of its provinces, Heilungchiang, is larger than Germany.

The foreign trade of China is continuously expanding. Civil wars and other political disturbances provide set-backs from time to time, but it has a recuperative energy that overcomes all these obstacles. And there is always the possibility of gradually introducing new industries to the Far East. As shown by the Chinese Maritime Customs Reports the number and different classes of workers interested in the making and receiving of goods from China is almost uncountable. While it is true that of recent years British goods have generally shown no advance, the Orient has still room for more commercial interchanges. Railway development affords a better means of communication and brings distant parts of the country within easy reach of the ports where cargo is landed from "foreign parts." Many up-country towns in China are still almost inaccessible to goods on account of the difficulty and cost of transit and the dangers of communists and bandits; but the capital involved in everything that concerns railways and the trade they facilitate improves the means to purchase foreign goods so ardently desired by the Chinese.

Manchuria, Manchukuo, is the most progressive part of China.

Japanese initiative has permeated the whole land. Peasant workers returning for the winter to their homes in China can bring travellers' tales of innovations and the wonders they have seen even in remote corners of Manchuria's boundless plains, that open the eyes of their families.

The population, according to the latest figures obtainable, numbers 30,000,000.

For many years Manchuria has attracted great numbers of settlers from North China because of its fertility and the way the land responds to the intensive and indefatigable methods of their farming toil. It is the scene of the greatest peaceful immigration of the modern world—the irresistible expansion of the crowded millions of China. No truer or more delightfully interesting account of the life led by these people has been written than that described by Mrs. Pearl Buck in her book "The Good Earth."

The prosperity of Manchuria depends largely on these immigrant farmers. The more beans we take from them the more manufactured goods will they take from us.

Owing to our lack of knowledge and interest in the potentialities of the plant there has not been much progress in recent years in the demand for soya beans and oil. Misrule, banditry and general political unrest in the Far East have, to a certain extent interfered with the production, and the silver rate of exchange is a constantly varying factor that causes commercial fluctuations. As all the world knows, Manchuria has been created an

independent State and is a separate entity from China, that is to say, China proper, south of the Great Wall boundary line.

Manchukuo under its new King and his Legislative Council is, as an independent State a *fait accompli* and when this is acknowledged the next best thing from our point of view is to maintain our trade on a purely commercial basis, unhampered as far as possible by political criticisms and considerations.

On many occasions in the past we have burnt our fingers in attempting to regulate Oriental diplomacy and politics. Japan has assumed a position of pre-eminent importance in Manchuria and all that concerns it, including the soya bean trade. By assiduous research and industrial activity she has developed the trade to a higher standard than could have been reached if it had been left entirely to Chinese initiative, even though the Chinese are the actual mainstay of bean production.

There is a plentiful supply of soya beans in Manchuria, sufficient to satisfy all our demands at a fair market price, and there is, moreover, the "open door" in products of this kind.

The annual value of the bean export from Manchuria is over 207,000,000 Haikuan taels. At a low rate of exchange, for the Chinese silver currency has no par value, this equals £22,000,000, a sum that must be a very considerable economic factor in the well-being of the country. Beans, bean cake and oil represent over 50 per cent. of the total exports.

The soya bean trade in the United Kingdom is unknown to the general public: it is as yet in its

infancy. Though as a constituent of several well-known piquant sauces and other comestibles, it finds wide use. For some strange reason specific mention of the name is rarely made on labels or descriptive literature about the articles. Perhaps some manufacturers prefer to regard it as a " trade secret " and to maintain a conspiracy of silence, but whatever the reason, our present utilization of the bean is infinitesimal compared with what it could be if the business were as developed as it is in the United States. There the industry has been fostered by the Government and by the National Soya Bean Association till it is now established on a firm basis. This has been greatly aided by the vast amount of scientific work undertaken by United States Agricultural Department experimental workers who freely place the results of their labours at the disposal of all who are concerned in the growth and production of the bean.

The same remarks apply, but in greater extent, to Japan where the importance of the bean has been realized, so that it now constitutes an imposing proportion of that nation's foodstuffs in addition to providing raw material for various industries. The South Manchurian Railway authorities have organized the work of collection and transportation of bean crops from a vast area and the facilities and encouragement thus provided have received ready response from the Chinese immigrant farmers so that not only has the trade grown amazingly but it is showing itself capable of answering wider demands. This development is marching hand in hand with research. In order to link science and industry more closely together the Kuantung

Government transferred its great Central Laboratory at Darien to the South Manchurian Railway on condition that all chemical tests and results of investigational work were made free of charge to the general public. The production and utilization of bean crops have benefited enormously from this scientific help which has opened up avenues of exploitation that can only be followed by expansion of the trade. When we think of Japan's dramatic rise to world commercial fame it may be worth while to remember that this "Britain of the Far East" has found the soya bean of such importance that it absorbs nearly half of the total Manchurian bean exportation.

Has the time not come when we in England should pay more attention to the potentialities of a greater interest in the soya plant? In Europe most of the scientific study of soya products is being conducted in Germany but only a small fraction of the results has been made public since the aim has been, in the majority of cases, the security of patents.

Later on we shall see how British cultivation of the beans has at length been successfully accomplished and what an enormous benefit would be received by British Agriculture if we could produce our own soya oil and provide bean cake for cattle food and flour for human nourishment. It is most desirable that we should cultivate it for, with the exception of rape and linseed, no other oleaginous seeds are grown in this country.

Although in England it was only so recently as 1934 that the first successful soya crop grown on a field scale was harvested, an impetus has been pro-

vided and in 1935 reports were available that the bean is cultivable in most of our counties.

When one talks to seed merchants and farmers about the bean it will be found that they lay emphasis upon the question of profit to the grower. But this is difficult to answer. Immediate profits must not be expected: there is still much pioneer work to be done and several problems to be solved before we can begin to compete with the foreign supplies.

If H.M. Government were to grant a subsidy the success of British-grown soya would be assured. Such a subsidy would be on a different basis to that granted to the sugar beet industry which has never been able to show any prospect of paying its way. A soya bean subsidy would tide the home-growers over the initial years of their crops and could be made subject to supervision by a soya commission. It would not tread on vested interests in the same way that home-grown sugar beet does with our sugar producing colonies. The total Government grant would not require to be large as the profitable nature of the crops would ere long render it unnecessary once the home soya market is established. The subsidy would be used to bridge the gap between crop production and increased demand. The official fostering of the soya trade could best be made by a subsidy which is preferable to a Marketing Board, for in more than one instance these Boards have gone too far in reducing supply in order to fit the lower level of demand.

The importance of this bean may be gauged from the fact that, according to the latest annual returns, its world production amounts to 12,000,000 tons.

The following are the official recorded (1935) figures of soya producing countries :—

Manchuria ..	5,200,000	tons
China	4,800,000	,,
Japan and Korea	950,000	,,
U.S.A.	480,000	,,
U.S.S.R. ..	100,000	,,

Here then is a major crop which merits introduction to British producers and users. The market for British-grown soya has not yet been properly developed but once the demand starts it will go ahead.

By growing our own crops we could save the cost of overseas transport and import duties and so place the trade in soya products on a good profitable basis.

CHAPTER II

THE SOYA BEAN PLANT AND ITS CULTIVATION

Nomenclature — Introduction into Europe and the U.S.A.—Description of the plant—Soil growth—Soil inoculation—Rotational crops—Yield of seed—Cultivation—Comparison of Eastern and Western methods—Varieties of the bean—American varieties—Method of cross-breeding — Soya bean cultivation in England — Analysis of the Bean from English grown plants.

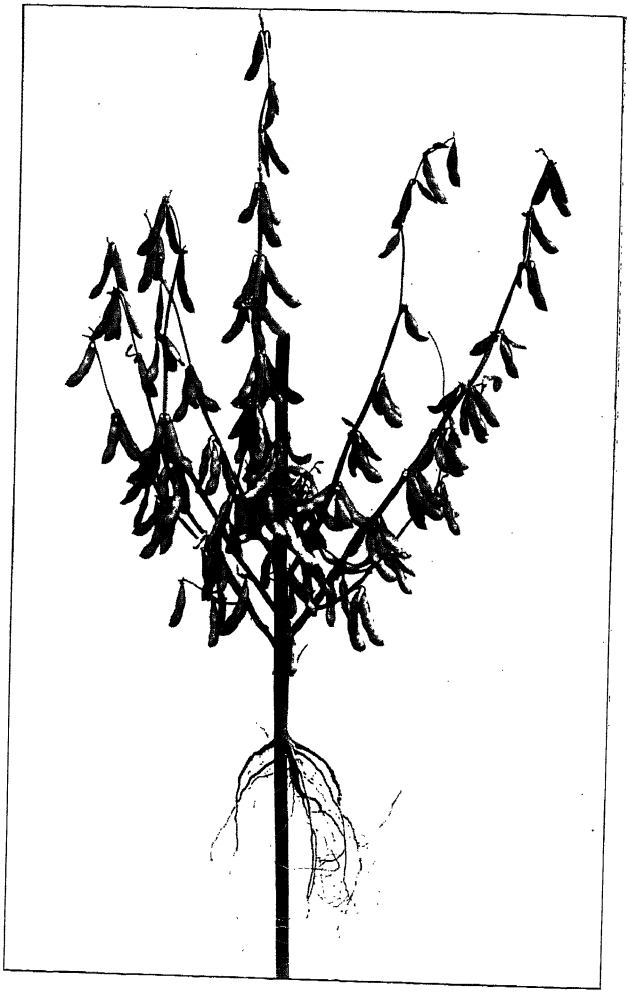
THE Soya Bean is the seed of an annual leguminous herbaceous plant indigenous to China, Korea, Japan and India, the Philippine Islands, Malaya, Australia and Africa.

In botanical literature it is usually known as *Glycine hispida*, and it belongs to the *Papilionaceous* tribe of the Leguminous family. Under the international rules of botanical nomenclature the plant is known as *Glycine max*; under American rules it is called *Soja max*. In China it is known as *Huang tou* (yellow bean).

There is a wild soya bean, *Glycine ussuriensis*, which has a slender, twining vine with small pods and very small black seeds, which occurs in China, Manchuria and Korea.

The soya bean is known also as Soja bean, Coffee-berry and Japan-pea.

It was brought as a botanical curiosity to England in 1790 and was reported as growing in New England by an American botanist in 1829.



The soya bean plant. Grown in England by Mr. J. L. North.

Later, in the nineteenth century, it appeared in Austria-Hungary where an unsuccessful attempt was made to produce it as a market crop. In Europe it is now mostly cultivated in Hungary and Czecho-Slovakia. Over fifty years ago the famous Austrian, Professor Haberlandt, predicted that the time would come when the soya bean would play a very important role in the diet of the poor because of its high fat and protein content and its comparative cheapness. In Germany also it is being grown, though not as yet to any great extent: much larger amounts are imported.

But it is in the United States that the greatest progress has been made in cultivation. Though introduced there in 1829, very little attention was paid to the subject until 1882, when the Mammoth Yellow variety appeared and was followed by an increase in production. Since 1900 the value and uses of the soya bean have become better known in that country, although as late as 1910 very few American farmers were growing the bean and only a few Governmental Experiment Stations were taking the matter up. It was at that time regarded as being able to furnish a crop primarily for forage purposes and, as is now the case, largely for production of foodstuffs. No one in America foresaw what an important and extensively grown crop of considerable economic value the bean would so quickly prove itself to be.

Prior to 1908 the production of soya beans was largely confined to the Orient. Though still principally cultivated there, the bean is of more or less importance in Northern India, Indo-China, and Malaya. It has been introduced into Italy,

France, Southern Russia, Hawaii, Egypt, South Africa, Canada and South America, in fact wherever the summer sun shines long enough to bring it to maturity.

Description of the Plant

The soya bean is an erect bushy annual which averages two to four feet in height and bears pods two inches in length, containing one to three seeds, which are enclosed in thin elastic pods of different shades of brown. There are about sixty pods on each plant. The bean possesses the great advantage of being self-pollinated, its flowers being perfect, producing both pollen grains and ovules. As pollination takes place before the flower opens crossing by insect agency is almost an impossibility, and different varieties can be grown together without risk.

The leaves are trifoliate, and are covered with numerous fine hairs. As the time for maturity approaches, the leaves of the yellow cotyledon varieties turn yellow and finally drop off. In some green cotyledon varieties the leaves do not turn colour; they remain green until they drop, leaving the stem bare except for the pods.

The flowers are small and are purple or white. They are borne in axillary racemes or peduncles at the nodes and appear first at the base of the main stem, then progressively towards the tips. The period of flowering is two to three weeks, hence the pods come to maturity at almost the same time, though sometimes a little later.

The pods, which are straight or slightly curved, split readily when mature and by curling throw out the seed, a process known as "shattering."

The seeds vary greatly in colour, size and shape. They are pea-like, containing an embryo, two cotyledons, two seed coats but no endosperm. Practically all the nourishment in the seed is contained in the cotyledons. The most common colours are cream-white, yellow, olive, blackish-brown and intermediate shades. They have a long scar and are without indentation on the surface.

In Manchuria the classification of soya bean plants is according to colouration of the seeds, but there appear to be no other characters correlated with seed colours, with the possible exception of richness in oil-bearing. This may explain the preference shown by European crushers for the yellow bean, more especially the American yellow bean, which is Federal-graded and more uniform in quality than the Manchurian bean.

The roots. There is a central root of the same diameter as the stem of the plant. It throws out numerous branch roots from its upper part, which runs horizontally, and these branch roots end in a thick mass of thinner fibrous roots. Most of the roots are in the first foot of the soil, but in dry seasons frequently they penetrate a foot deeper. Where inoculated, each branch root has a number of nodules that vary in size from a pin-head to a pea. It is in these small round nodules that nitrogen-gathering bacteria live. Unlike other legumes the bacteria from other species of crops cannot produce nodules on the soya bean. The plant is not wholly dependent on its roots for nitrogen, for it absorbs a large part of its requirements from the nodules.

Soil growth. The beans grow best in soils of

medium texture, containing fair quantities of potash, lime and phosphoric acid. Good results have been obtained in comparatively light soils and an abundant crop can be produced on land too poor for clover. In America good crops have resulted from growth in sandy limestone or marly soils, also on drained swamp or peaty lands. In Manchuria this experience is confirmed, as beans are to be seen growing and flourishing everywhere. The bean district *par excellence* is the upland country beyond Moukden, where the hills are overlaid with wind-deposited soil, which, being friable is particularly adapted for the growth of a shallow-rooted plant like the soya. It grows well too in the plains with their water-deposited soils, which, enriched by a plentiful leaf-deposit, are loamy and of a favourable nature for bumper harvests.

It is noteworthy that while on good soil the plants develop well, the amount of seed yielded is correspondingly less, while on poor soils the plant development is relatively small in comparison with the seed. Soil has much to do with the variety of product. It has been found that a poor soil makes for a higher oil content and a rich soil produces a bean rich in protein.

Waterlogged soil is very unsuitable, as also are soils that are liable to become too sun-baked. In the former case, to ensure good results, the land must be prepared by drainage, and in the latter thorough disking or harrowing is essential.

With proper management soya beans will grow well on soil that is too thin for corn, wheat, oats, maize or barley. In the Governmental Experimental Station at Missouri crops of soya beans

have been produced that yield ten or twelve bushels of beans or two tons of bean hay to the acre on some of the thinnest land in the State, with no use of fertilizer or manure.

Soil infestation or inoculation. In order to ensure good plant growth it is necessary that soil should contain nitrogen, of which there is an unlimited supply in the air. Nitrogen in the form of chemical soil fertilizer is an expensive element to supply. Because legumes, such as the soya bean, have nodules on their roots which secrete their own supply of nitrogen, it is unnecessary to give them artificial nitrogenous fertilizers.

An interesting description of the process of soil infestation was written in 1910 by Mr. Norman Shaw of the Chinese Maritime Customs in his Report of the Soya Bean of Manchuria. Under the heading of "Soil Infestation" he says:—

"The nitrogen gathering bacteria form excrescences called nodules on the roots of the bean. By means of these bacteria enzymes are produced which are sent through all parts of the plant, mainly to the leaves, and the free nitrogen of the air is, by virtue of the enzymes absorbed from the surface of the leaves and sent by some mysterious chemical process through the plants to the roots.

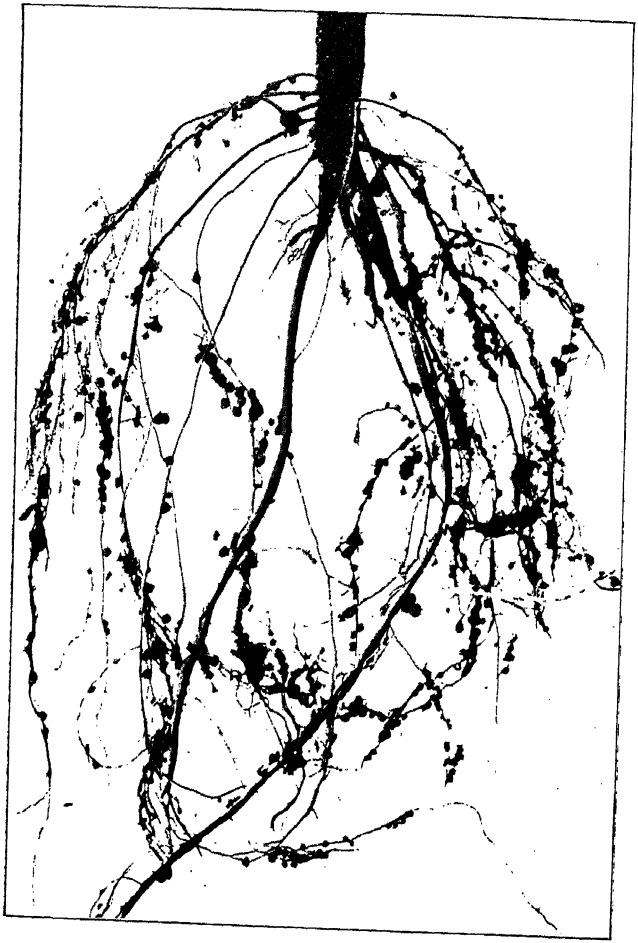
"The plant, by giving to the bacteria 2 per cent. of sugar food, receives in exchange 95 per cent. of nitrogen. When roots and legumes die in the ground, the nitrogen which the bacteria have already gathered and stored in the nodules is given to the soil, which is then rich in nitrogen. When the next crop is planted in that soil, no matter what the crop may be, nitrogen is there, and the crop will benefit by it. In 'green manuring' when a crop of green leguminous plants is ploughed under,

it decomposes and enriches the whole soil with nitrogenous compounds, the process being infinitely more beneficial than the heaviest application of fertilizer made in farm practice."

In Asiatic countries where cultivation is on an empiric basis and farmers work their fields in the same way as preceding generations of ancestors, little is known about soil inoculation. The bacteria suitable for inoculating their beans are widely distributed by Nature in the soil and the nodules present on the roots are there by natural inoculation which occurs quite generally throughout much of the regions where soya is grown extensively. The Bureau of Plant Industry of the United States Department of Agriculture has recognized the importance of inoculation and in a series of scientific investigations has shown that 50 per cent. more nitrogen is found in the stems and leaves of soya beans which are planted in inoculated soil than in those grown on uninoculated soil.

American farmers are therefore recommended by their official advisers to procure inoculated soil (which can be obtained from a field which has already produced a crop of soya beans) when planting beans for the first time. Or they can avail themselves of commercial cultures or obtain material from the Agricultural Department of their State.

This whole subject of inoculation has, however, undergone revision following the research work done by European botanists and what we in China regarded in 1910 as a satisfactory explanation has now been shown to be incorrect. Various botanical works have dealt with the matter and the facts are



Roots of a soya bean plant showing abundant development of nodules. This is a properly inoculated soya.

simple. The higher plants are unable to take free nitrogen from the air but certain bacteria can do so. In the case of a leguminous plant if it is unable to obtain from the soil the nitrates it requires for growth it enters into a bacterial association with *Bacillus radicicola* for mutual benefit. The bacteria enter through the root-hairs and penetrate to the zone where growth is taking place, where they are imprisoned and become surrounded with a wall of cells whose rapid increase causes a swelling which later becomes a nodule.

From the leaf elaborated sap as it travels downwards to the roots, the plant supplies the bacteria in the nodules with carbohydrates for food. As there is no communication with the outer air the bacteria combine these with nitrogen obtained from air within the plant tissues to form the protein of which it is mainly composed.

The bacteria increase in number by cell division proportionately to the amount of food sent down, and fill the surrounding cells with smaller editions of themselves known as bacteroids. These cells are emptied by the plant as it requires nitrates and the process goes on as long as growth is taking place.

When the plant dies, the nodules break up and the bacterial contents are deposited in the soil, enriching it proportionately to the number of nodules carried by the plant roots. As far as can be gathered there is no compulsion, by either, of the alliance. The bacteria can live apart from the plant in the soil humus if the plant has a sufficiency of nitrates, as where the ground has had a dressing of farm yard manure, in which case it resists infection and no nodules are formed.

Nodulation is a habit, and like most habits is not obligatory. In England inoculation seems to make little or no difference to the crop. In America it is regarded as essential for success with soya. In parts of Central Europe soya beans were grown successfully long before anything was known about inoculation and therefore could not have been infected by bacteria. The reason for the difference is probably to be found in the different climatic and soil conditions of Europe and America. There can be no doubt about the fact that inoculation and nodule formation add nitrogen to the soil, thus helping succeeding crops, and for this reason alone it would be worth while for each country or locality to maintain its practice. The combination of climate and soil is one of Nature's secrets which has not yet been penetrated, e.g. the Scotch whisky or Chateau wines in France in which the methods of production are well-known and where the water and soil have been subjected to the closest analysis for purposes of manufacture in other countries, but without success. Nowhere else in the world does water flow which has exactly the same combination of properties as the river Spey in Scotland on whose banks distilleries congregate and it is the same case with the soil of the various proprietary vineries such as the Chateau Yquem or the Chateau Lafitte from where the far-famed vintage clarets of inimitable bouquet come. I am indebted to Mr. J. L. North for putting me in possession of the latest scientific views on the processes involved in inoculation, which are without doubt more correct than the views advanced by Mr. Norman Shaw.

There are five different methods of soil inocula-

tion by soya bean bacteria practised in the United States. In view of the persistent attempts to grow the bean in England it is well to state these methods here : they may prove helpful.

(1) Drilling or broadcasting 200 to 500 pounds of inoculated soil per acre.

(2) Applying one to two quarts of dry sifted soil to the bushel of dampened seed.

(3) Mixing equal parts of weight of seed, and soil from a previously inoculated field.

(4) Dampening the seed with pure cultures supplied by laboratories.

(5) The use of commercial inoculants prepared by private concerns.

All of these methods are usually satisfactory on clay or loam soils but on coarse sandy soils the first, second and third methods are probably more efficient.

By the age-old, primitive methods of agriculture in Manchuria, the Chinese farmer, unaware of the valuable soil infestation and soil improvement properties of the soya bean, pulled out (and in a number of instances still continues to do so, as I have personally observed) the whole plant by the roots and cut up the roots with a mattock for fuel, thus preventing the work of the *Bacillus radicicola* from bearing fruit, and depriving his land of the provision made for it by Nature. He further deprived it of any beneficial effect upon a succeeding crop of corn.

Under Japanese supervision and encouragement modern methods are slowly spreading among these Manchurian colonists so that the fertility of the soil may be preserved.

Rotational crops. The soya bean has now come to occupy a permanent place in many of the rotations of the farming systems in the eastern half of the United States. Its high fertilizing value is steadily receiving more recognition.

Not long ago experiments were made in New Jersey, U.S.A., to determine to what extent the nitrogenous supply of the soil could be maintained by growing a legume between the main crops of rotation, and it was found that wheat following a non-legume yielded at the rate of 9 bushels of grain and 1,040 lb. of straw to the acre. But wheat following soya beans as a green manure yielded 17½ bushels of grain and 2,540 lb. of straw. A notable difference.

Following a non-legume, the nitrogen in the dry matter of both the grain and straw amounted to 18 lb. per acre for wheat and 23 lb. for rye, as compared with 39 lb. and 40 lb. respectively when grown after soya beans.

Though the Chinese farmer intuitively understands the importance of rotation where his other food crops such as corn, rice, maize, and millet are concerned, his ignorance of proper manuring has resulted in soil exhaustion. Thus the soil in South West Manchuria where agriculture has been carried on for ages, has become bereft of vegetable and organic matter to the extent of no longer bearing the same rich harvests.

If these peasants were aware of the value of "turning under" the plants after the harvests, the fertility of the land would be preserved.

It is a remarkable feature of leguminous plants that when associated with bacteria they can take

nitrogen from the air, thus differing from non-leguminous plants which must absorb their nitrogen from the soil only.

Yield of Seed. With regard to this, the late Sir Alexander Hosie, British Commercial Attaché in China (and in his time a most indefatigable and careful observer of all that concerned the numerous productions of China) stated that the yield of soya beans per acre, which required from 16 to 18 lb. of seed, could be estimated at from 27 to 39 bushels per acre with a weight of about 40 lb. per bushel, that is, from 1,100 to 1,600 lb. per acre.

A Japanese agricultural expert found that in some districts the yield was 20 to 49 bushels per acre while in poorer districts along the Yellow Sea coast it was only 10 to 15 bushels per acre.

In England the four successful varieties acclimatized by Mr. North yielded as follows :—

The "Jap" variety.—15 bushels per acre from 30-inch spacing between the rows, though it is believed that closer planting could be successfully carried out as the "Jap" plant is densely podded and of dwarf growth.

The "C" variety.—25 bushels per acre from 27-inch row-planting and 4-inch spacing.

The "J" variety.—18 bushels per acre from 30-inch row-planting and 4-inch spacing.

The "O" variety.—15 bushels per acre from 30-inch row-planting for forage (hay) seed.

It matters little whether the seeds be carefully sown in rows of varying spaces between or whether sown broadcast. There is no marked difference in yield of seed.

In the United States the average yield is somewhat lower. But even so, under favourable conditions the better varieties of seed have yielded between 15 and 25 bushels per acre. On land that produces 30 to 40 bushels of corn per acre they secure 15 to 25 bushels of soya beans.

As methods of cultivation progress, so also do the improvements in returns. I have received reports of soya crops in the United States which have produced as much as four tons of hay and 40 bushels of beans per acre.

Returns such as these have aroused the commercial attention of the American farmer and have led him to devote greatly increased acreage to the production of soya beans: 1,000,000 acres more were planted in 1935 than in 1934. In Illinois, a State in which the bean production is largely centred, the average acre-yield for six years was 15·6 bushels, with only one year in which the yield was 20 bushels. Later, by improved methods, the average yield was 22·4 bushels. In Indiana the average yield was 14 bushels per acre. In Missouri it is 20 to 25.

Cultivation. From one-half to three-quarters of a bushel of seed per acre is required though in some regions the Chinese use only half this amount. The seed is sown at a depth of from one to three inches. In clay soil one inch suffices, but in sandy soil it is better to sink it three inches.

Sown in May the harvest takes place in September in countries north of the Equator. The pods are usually reaped before they are quite ripe as otherwise they are liable to burst when drying, a loss of seed being the result.

The Chinese farmer's method of cultivating and reaping is primitive. His work is almost all done by hand, in the same way as that described in the Old Testament. His plough is of the type used in Biblical or pre-Biblical times. It has a single hand shaft and a rough iron coulter and does not plough deep. He uses a heavy hoe to break up humps of soil and sows the seed by hand. Usually a sharp, straight sickle is used for reaping. Sometimes the method of pulling by hand is employed. The plants are allowed to dry and are then carried to a beaten earth threshing floor, where the threshing is done by a donkey which pulls a roller over them.

Next, the straw is removed and the beans are brushed into a heap and winnowed by being gathered in a basket and thrown up into the air which wafts off the chaff. The crop is then gathered in sacks and trundled in a wheelbarrow to the nearest market.

In Europe and America modern methods of cultivation and harvesting result in a higher yield. The soil, if of hard surface, is broken by harrow or rotary hoe before the plants are ready to come through. If cut for hay, the mower is most commonly used. If for seed, then the self-binder is used and the beans are handled in practically the same manner as any other grain. The sheaves are set up in small shocks and allowed to cure in the field. They can then be successfully stacked.

The next step, the threshing, can be done with an ordinary grain separator, though the speed of the cylinder must be reduced to one-half the rate for grain. There are various bean hullers on the market which thresh soya bean satisfactorily and

in the United States special harvesters or strippers have been developed to gather beans grown in rows. These machines strip the beans from the standing stalks, depositing the material in large hoppers. There is also a cleaning equipment to separate the clean seed.

Constant improvements are being made in these mechanical pickers which have the great advantage of doing the work in a single operation, thus reducing the harvesting costs. The pickers shorten the harvesting season and leave the residue in the field where produced, in addition to enabling the farmer to gather his crop with less loss than by other methods.

It is a matter of importance to handle the seed so that after threshing it does not get heated or stored in bins with a high moisture content. If stored in sacks, under cover and not corded up, there is ample air for drying.

We can see how vastly different are the eastern and western methods. At first sight one reflects on the wasteful, laborious manhandling style of Chinese harvesting compared with the perfection attained by modern labour-saving machinery. But there are economical considerations to be faced.

The native small farmer can give employment to all his relatives and friends from the same village in North China from which he migrated—a point of importance in lands where unemployment grants have no existence and where there are no frantic Back-to-the-Land appeals—no Quotas—no Government Subsidies. Moreover, he has no capital to buy agricultural machinery. There are, however,

From "The Vegetarian News."

The soya bean in Manchuria.

millions of these peasant farmers working millions of acres of beans. The sum total of their ceaseless toil is a huge output of beans, produced at a rate that permits sales at prices favourable to the European purchaser. The quantities available can supply greatly increased world demand as more uses are found for this wonderful bean and all the products made from it.

Soya bean varieties.—The natural object of a scientific agriculturalist in making different varieties is to improve the various strains. The only practical means the plant breeder has of inducing variation is by hybridization, i.e. by making artificial crosses. The process is interesting enough to warrant description. The flowers are placed under a magnifying glass and then, by the aid of a needle and fine pointed forceps and scissors, emasculation and pollination are performed. First the sepals and corolla are cut off. Then the anthers are examined to see if they have burst open and whether their pollen grains seem separate. If the pollen grains are in ripe condition the anther is then gently rubbed over the stigma of an emasculated flower, such emasculation having been secured by removal of its own anthers. In this way pollination is effected.

The soya bean breeder can thus effect a number of different types for improvement purposes; e.g. varieties which differ greatly in the relative resistance and susceptibility to plant diseases. He may evolve a bean which may find great favour among mill crushers because of its increased oil yield.

The whole purpose of cross-breeding has for its object the production of types with all the yield components expressed to a higher degree than in

the parents; it appears to be a promising method of breeding.

In assessing the best varieties of beans for certain localities, uses and climates, regard must be paid to the physical structure. There are stout, bushy, dwarf varieties that will mature in one hundred to one hundred and five days, while there are taller kinds that are not ready till a month later. It is thus possible to foretell the approximate date of maturity. If grown for hay, it is best to select fine stemmed plants, with heavy leaf production. If for beans, the larger pod varieties containing big seeds are preferable; if for climate, then the growth period is the dominant factor, in order that the stage of maturity can be reached before cold weather sets in.

In Manchuria and Asia generally there are three main classes of soya bean: (a) the Yellow, (b) the Green and (c) the Black. The Yellow-skin beans of the Manchurian Plains are commercially differentiated into the Yuan Tou (round bean), Chin Yuan (round golden), Pai Mei (white eyebrow) and Hei Ch'i (black navel).

But there is a great variety of sub-species each differing in some small peculiarity. Brown and mottled beans are unknown in Manchuria, though grown in the rest of China, Korea, and Japan. These are not regarded as botanical varieties but as agricultural forms differing in size, shape and colour of seeds, height and habit of plant, and in earliness and lateness of maturing; all of which characteristics, except the colour of the seed, vary greatly with the climate and soil.

The number of known varieties or sub-species in

Asia and the United States, is well over two thousand, though in Manchuria the number commonly grown is fifteen.

In the United States one of the oldest, best and most generally grown variety is the Mammoth Yellow, which gives a good harvest of seed per acre. Its bean is of straw yellow colour. Next in popularity come Tokyo and Herman which are also yellow. Two good black varieties are Laredo and Otootan, and three more that find favour have brown seeds—Biloxi, George Washington and Virginia. The following are some more important American varieties:—

Mammoth Yellow	Medium Green	Mammoth Black
Dixie	Hahto	Biloxi
Haberlandt	Lexington	Black Eyebrow
Herman		Geo. Washington
Ito San		Laredo
Manchu		Otootan
Mandarin		Peking
Midwest		Tarheel Black
Tokyo		Virginia
		Wilson Five
		Wisconsin Black

Although the list of varieties and strains that have been studied and described is a very long one, comparatively few have proved promising and the majority have had to be discarded as being of no economical importance.

At present in the United States about sixty varieties are dealt with by farmers and seedsmen. Unfortunately there is much confusion in the names, the same variety frequently being known under several different names. As new varieties are easily obtained it is desirable to limit their

number in trade to the very best yielders of quantity and quality. In the United States the seeds of the best varieties are certified by Crop Improvement Associations.

In Manchuria the farmer goes on year after year producing his bean crops, paying but scant attention to varieties, using the seeds he has got and finding that these routine crops answer both Chinese and foreign demands satisfactorily. But in the United States there is a constant urge towards scientific progress and development of the plant with a view to improving certain special features. They do not regard the soya bean as having by any means yet reached its full possibilities. They foresee a great future for this versatile plant and have every intention of making it an agricultural success. They will continue to breed the plant till they have obtained the best results for forage, food or oil.

Cultivation in England. This is still in the early stages and British grown soya beans can scarcely as yet be considered an economic proposition.

Though introduced nearly one hundred and fifty years ago and grown from time to time at Kew Gardens, the plant has not till recently been kept going. Until acclimatization takes place the bean may not settle down into regular successive crops.

Adaptation not only to soils but to climate and seasons is a slow process, especially during the critical period of germination; but it *can* be done, as has been proved both by Mr. North and the Fordson Estate in England and on the Continent: also, as we have seen, in the United States of America.

There is no soya bean native of England. All

the plants have had to be introduced and grown, on and on, year after year, by private individuals, for we lack the continued effort of official fostering and cultivation. It is noticeable in the United States that the varieties most grown are those that have been longest in the country and have therefore become climatically adapted. Messrs. Sutton and Sons, Ltd., of the Royal Seed Establishment at Reading, devoted considerable time to the subject of experimenting with the soya bean, but without what one might call "official support" the demand for seed was so poor that they decided to discontinue offering it. Moreover the cost of production in England is up to the present so much in excess of the market value of Manchurian beans, that we must wait some further time before it becomes commercially practicable.

In warm dry summers there is little difficulty in the South of England in maturing acclimatized seed, but when the summers are poor, harvesting is late and it is sometimes difficult to get the beans dry enough to be thrashed direct from the field.

In Mr. North's pioneer practical work he has specialized on acclimatization and in 1933 tested forty-six varieties of soya in a single plot. These were chiefly early varieties brought from the Northern States of America with three from Canada. In July of that year all of his acclimatized varieties were in flower, but none of the others had reached that stage.

He has experimented for more than twenty years with varieties obtained from friends in different parts of the world, and from about one hundred and fifty different varieties he has got four which can be cultivated in this country in a normal

season. All of these belong to what in the United States are called "very early" varieties. There they would probably mature in eighty to one hundred days or even less, but in England, because of the lack of sunshine and heat they would take at least a month longer. A good many would ripen in October, but could not be harvested because of wet weather. Prevailing climatic conditions in May largely govern the time for sowing; it is not feasible to sow earlier because the ground is too cold. For sowing seeds the surface temperature of the ground for the first three inches should be 55° Fahrenheit. In our farms an open sunny situation with complete freedom from the shade of trees (which would halve the output of soya plants) is essential for sturdy growth. Otherwise, given a fair climatic chance the soya plant is easy to cultivate, being both hardy and adaptable as regards soil. Although a light loam is preferable the plant could thrive on our chalky or sandy soils.

While the possibilities of its growth in this country are still in the early stages, the Southern, Eastern and Midland districts show most promise as cultivating areas. In the west of England it is thought there may prove to be too much moisture.

In October 1934 it was reported in the Press that the first crop of soya beans ever grown in Great Britain on a commercial scale had been harvested on the Fordson Estate at Boreham, near Chelmsford, Essex. It was claimed that these beans were better, if anything, than those produced either in Manchuria or America. At Boreham, by Mr. Henry Ford's directions, forty-six varieties were subjected to experimental tests, and of these, four (acquired from Mr. North) were found successful.

The good lead given by the Fordson Estates has "blazed the trail" for other farmers.

Our climatic conditions call for extended pioneer work. Further experience may result in the discovery of an early variety that will regularly mature within the limits and vagaries of an English summer and yield a profitable crop. Though the British climate is irregular and we are subjected to bouts of unfavourable weather, ours is not the only country which has to submit to adverse climatic conditions. In America and the Far East, soya crop supplies are sometimes irregular and diminished because of excessive cold, rain or drought.

In the meantime, those of our farmers who may take the matter up would find that, for forage purposes, soya hay, before it is allowed to reach the full stage of bean maturity, is a most valuable cattle feed, richer in nourishment than alfalfa or any hay that is now grown. Soya hay will tolerate excessive moisture and survive quite severe drought.

SOYA BEAN ANALYSES FROM MR. NORTH'S ENGLISH GROWN PLANTS.

Made by C. E. Brook, British Oil Mills, Rochester, Kent.

Varieties	"A"	"B"	"C"	"J"
Moisture ..	10·00	11·00	11·00	10·67
Oil	16·83	16·30	14·66	15·93
Albuminous compounds ..	33·51	34·65	34·74	36·23
Carbohydrates ..	31·10	29·78	33·43	27·77
Woody fibre ..	3·23	3·30	3·10	4·43
Ash	5·33	4·97	3·07	4·97
	100·00	100·00	100·00	100·00

"A." North's variety, yellow, grown in England since 1914. Analysis made 1926 from Chiswick, London, grown seed.

"B." A brown Manchurian variety received from Washington, U.S.A., 1922, grown in England 3 years. Analysis made in 1926 from Chiswick grown seed.

"C." "Manitoba Brown," a selection from a hybrid brown American variety "Ogamaw," received from Prof. Southworth, Manitoba Agricultural College, Winnipeg, 1922, grown in England 5 years. The analysis is from seed grown at Suttons, Reading, 1926.

"J." A yellow Manchurian variety, received from Washington, U.S.A., 1924, grown in England 4 years. Analysis from seed grown at Chiswick in 1927.

ANALYSES.

VARIETY "C" SOYA BEANS.

Year	1929	1929	1929	1926	1927	1928
Grown by	Christchurch Hants.	Suttons, at Reading	J. L. North, Chiswick	J. L. North, Chiswick	Imported from Winnipeg by J. L. North	Ag. Com. Weat. Suffolk
Moisture ..	11·67	11·00	14·33	11·00	9·00	11·67
Oil	13·36	15·51	13·60	14·66	16·69	13·84
Albuminous compounds	39·29	38·50	39·02	34·74	38·24	32·46
Carbohydrates	28·42	28·35	25·05	33·43	27·27	36·39
Woody fibre ..	3·03	2·97	3·90	3·10	3·70	1·47
Ash	4·23	3·67	4·10	3·07	5·10	4·17
	100·00	100·00	100·00	100·00	100·00	100·00
Containing nitrogen ..	6·39	6·16	5·92	5·56	6·12	5·19
Including silicous matter..	0·01	0·11	0·31	Nil	0·13	0·20

	Analysis of soya straw left after threshing	Compared with good meadow hay
Moisture	12·42	—
Oil	1·08	2·50
Albuminous compounds	6·00	9·00
Carbohydrates	47·86	41·00
Woody fibre	26·30	26·00
Ash	6·34	—

COMPARATIVE TABLE OF ANALYSES OF THE DIFFERENT LEGUMES.

Name	Moisture	Albuminous compounds	Oil	Carbohydrates	Woody fibre	Ash
Bean ..	13·49	25·31	1·68	48·33	8·06	3·13
Parched peas	13·92	23·15	1·89	52·68	5·68	2·68
Lentils ..	12·33	25·94	1·93	52·84	3·98	3·04
Soya beans	12·71	38·18	14·03	31·97	4·40	4·71
Peanuts ..	7·71	31·12	46·56	9·39	2·16	3·06
Green peas	78·44	6·35	0·53	12·00	1·87	0·81
French beans	88·75	2·72	0·14	6·60	1·18	0·61

These analyses show that while the protein content of soya beans is high, oil replaces a considerable proportion of the digestible carbohydrates.

CHAPTER III

THE SOYA BEAN AS FOOD

A summary of the principles of Dietetics—Proteins, carbohydrates, vitamins and other constituents — Comparisons with other foods—Glycinin-Lecithin-Cephalin—The different foods made from the bean—Immature green beans — Mature dried beans — Soya bean coffee and chocolate—Sprouts—Vegetable milk—Flour—Berczeller's flour — Ehrhorn's process — Bean Curd — Soy — Miso — Chiang—Improper Foodstuffs—Conclusions—Foodstuffs in which the bean or its products are used.

IN assessing the value of the soya bean as a food for both man and beast I propose in the initial part of this chapter to give non-medical readers a résumé of the constituents of food in general. It shall be as brief as possible, but it is necessary in order to understand the significance of the rest of the chapter, of the terms used: and from it we shall be better able to judge the relative values of the nutrient elements contained in the bean in addition to appreciating the highly satisfactory degree to which this special legume has reached in answering the requirements of an all-round useful food.

DIETETICS.

A broad classification of food constituents comprises (*a*) nitrogenous and (*b*) non-nitrogenous elements.

Nitrogenous. A large proportion of the nitrogenous elements of food are formed by proteins: these are substances chemically allied to the important nourishing element albumin, which is

produced in plants, especially in seeds. Albumin forms an essential part of the animal organism. The white of an egg is a well-known albumin : it is a simple protein.

Nitrogenous foods are necessary for the maintenance of animal life. They are required not only for the formation of new tissues and the renewal of old tissue, but for the digestive and other fluids of the body which would languish if nitrogen were withheld.

There are animal proteins and vegetable proteins. The former have a higher biological value, and are more rapidly and completely digested.

Non-nitrogenous. These are fats, carbohydrates, the vegetable acids, mineral salts and water.

Fats contain no nitrogen. They are made up of carbon, hydrogen and oxygen, and are digested and absorbed more slowly than carbohydrates. A meal lacking in fat is deficient in staying power. Fat is a vehicle for important vitamins.

Carbohydrates, also made up of carbon, hydrogen and water of different proportions to those of the fats, have as their chief function the production of animal heat and energy by oxidation and the formation of new fatty tissues. They are converted into grape sugar in the process of digestion. A diet rich in starch and sugar is fattening.

Carbohydrates are protein sparers inasmuch as they enable the body-need of protein to be satisfied by a smaller protein intake. They are concerned with maintaining the various body fluids (blood, lymph, gastric juice, urine, etc.) in proper condition. Starches and sugars have much the same dietetic value.

To maintain good bodily health, therefore, our diet must contain all the three substances—proteins, fats and carbohydrates. The proteins are the most indispensable, for without them, life would cease when deprived of the nitrogen they contain.

Vitamins. There is, however, another factor in diet which is indispensable to health and growth. Though it is not claimed that vitamins are nutritive, they are "activators" in the utilization of foodstuffs by the body and they therefore form a most important constituent of food. Their chemical composition is becoming gradually revealed in response to biological research. No one has ever seen a vitamin, but we know they are there and science has been able to differentiate them into two leading groups—fat-soluble vitamins which can be separated from foods containing them by solvents which dissolve fat; and water-soluble vitamins which can be dissolved out by water. They are distinguished alphabetically thus: Vitamins A and D are fat-soluble, and B and C are water-soluble. Vitamin A is protective in that it builds up the body resistance to infectious complaints of low virulence, such as influenza and the common cold; vitamin B is essential for young animal growth. Lack of it causes malnutrition and disorder of the central nervous system.

Vitamin C should be included in a diet, for if absent then that diet becomes defective and scurvy ensues. Fresh vegetables, oranges and lemons are richest in this vitamin. Vitamin D promotes efficient calcification of the bones and teeth. In its absence diseases such as rickets and dental disorders ensue.

The animal world is mainly dependent upon vegetable life for a supply of vitamins which are formed mostly in green plants through the agency of chlorophyll and light.

Mineral Salts. These are essential for the growth and repair of all the tissues of the body and are necessary for the diets of persons of all ages.

Calories. An efficient diet must possess an adequate calorific value. A calorie is the amount required to heat one pound of water four degrees Fahrenheit. The energy obtained from articles of food is expressed in calories. The chief expenditure of energy is devoted to maintaining the temperature of the body.

For the sake of comparison here are the constituents of some of the leading articles of food :—

Article	Protein	Fat	Carbohydrates	Calories
Rice ..	8·0	0·3	79·0	3,595
Beef ..	14·5	22·5	—	2,687
Mutton ..	14·5	25·0	—	2,879
Bacon ..	9·5	59·4	—	5,914
Milk ..	3·3	4·0	5·0	712
Eggs ..	11·9	9·3	—	1,353
Salmon ..	15·3	8·4	—	1,455
Oranges ..	0·8	0·4	14·3	656
Wheat ..	12·0	1·5	73·0 (70% starch)	3,612
Oats ..	14·3	1·5	67·0	3,550
Maize ..	10·2	3·0	72·5	3,630
Soya bean..	**42·8**	**20·0**	**28·0** (No starch)	**4,710**

From the above it will be seen that the soya bean is exceptionally rich in nitrogenous principles and, in the dry bean especially, there is a high content of easily digestible fat and but a slight trace of starch. Analysis shows that only part of the carbohydrates in the bean is in a form which is

utilized by the body. It has a high caloric value and contains more protein and fat than beef and eggs which cost more to buy.

For diabetic people who require a low starch diet it is specially suitable because of its practical freedom from starch which is as low as 0.8 per cent. This is remarkable when one considers that all other beans are rich in starch.

In the form of soya bread or biscuit or as gruel or a thickener for soup it has shown excellent results as a diabetic nutrient. It is not only palatable but satisfying and in addition its use as a diet is attended by a reduction in the amount of sugar passed.

As each ounce of the flour contains 13 grains of protein and has a caloric value of 120, it is obvious that it must be very nourishing. It is therefore passing strange that our leading dietitians in their search for starch-free aliment should be so unaware of the striking advantages of soya bean flour for diet for diabetic patients. Not only does it provide a starch-free and sugar-free diet, but it also solves the problem of assuaging hunger while yielding sufficient nourishment in a form that is perfectly suited to their needs. "Soyolk," manufactured by Messrs. Soya Foods Ltd. at Rickmansworth, is a most palatable and easily digested form of soya bean flour. Another firm, Messrs. Dietetic Foods, Ltd., London, make Heudebert Soya Flour. Both of these products have dietetic qualities which make them specially suitable for diabetic people. In France and Germany the virtues of the bean are much more appreciated by dietitians than in Great Britain.

Soya flour will be found, on account of its low starch content, to be a most effective substitute for such foods as wheaten bread and potatoes. Its carbohydrates are present in the form of digestible crude fibre and nitrogen-free extract.

Soya beans have about 650 lb. of digestible protein per ton which is more than three times the protein content of any other commonly grown grain, and more than four times the protein content of corn.

Yellow beans are as a rule richest in protein and fat: then green beans and then black.

An important feature of the protein present in the bean is that it is of high quality because of its richness in animo acids which are necessary for growth and are similar to those obtained from the casein of milk.

The nutritive value and digestibility of various proteins are due to the particular animo acids which they yield in the process of digestion.

The chief protein of the soya bean is glycinin which is soluble in water containing salt; in the form of glutonic acid it was used in German hospitals during the war as the basis of "beef tea."

Another notable feature in the nutritive efficiency of the bean is its richness in fat of a readily assimilated kind, and this extends its use as a staple food. Soya flour contains ten times as much fat as wheaten flour and in this fat is a considerable quantity of lecithin which is the best form of organic phosphorus known. Soya bean feeding thus increases the phosphorus content of the blood. This lecithin-containing phosphorus (Soya bean phosphatides) is of great value in building up our

nerve tissues. It is present to the extent of from 1·65 to 3·08 per cent., the latter figure being nearly identical with the lecithin content of whole eggs and calves' brains which are the chief source of commercial lecithin. Much patient research has been done of late in the extraction of phosphatides of the lecithin type from soya beans and in splitting off some of the carbohydrates which are present in the phosphatide complex. But no one has yet succeeded in preparing a soy lecithin with a phosphorus content as high as 3·94 per cent.—the figure for egg lecithin—nor has a way been found of obtaining the carbohydrate of soya phosphatides in pure crystalline form.

Cephalin, a constituent of the brain, is another phosphatide found in the bean. It differs from the cephalin isolated from animal sources and is a highly complex compound which has important therapeutic possibilities.

In France, on account of this lecithin phosphorus, soya bean preparations are used in preventive and curative treatment of neurasthenia because of the well-known property of phosphates in controlling fatigue. Lecithin of vegetable origin wards off fatigue.

In Germany and Denmark, during the last decade, mills for the commercial extraction of lecithin have been put into successful operation and over 1,000,000 lb. of soya lecithin are used annually in Germany for the production of margarine. This lecithin is extracted from the soya bean by a mixture of ethyl alcohol and benzine which yields about 50 per cent. of oil. Up to a few years ago eggs were the chief source of commercial lecithin which

is in great demand especially by chocolate manufacturers to increase the nutritional properties of their products.

In Japan, according to the latest news, the Manchu Daizu Sheihen K.K. (Manchurian Soya Bean Products Sales Co., Ltd.) are prepared to place on the market low-priced lecithin manufactured by the M.D. Hogyo K.K. (Manchurian Soya Bean Industrial Co., Ltd.) to be sold against all competitors. The cheapening of soya lecithin is bound to increase the demand and use of the article.

Soya beans are somewhat deficient in sodium, chlorine and calcium, though with regard to the last they contain nearly double the calcium content of cows' milk; the mineral ash is alkaline.

There is an average of 4·5 per cent. of ash in soya bean—potassium and phosphoric acid being the two leading constituents of it. The phosphoric calcium salts that are present are necessary to promote the growth of our bones.

The summation of the foregoing analyses and the explanatory notes on diabetics will help us to realize that in soya bean we have a food which is unique. It has come to be realized as being the most nearly perfect substitute for meat.

The yield of proteins from the bean, weight for weight, is approximately twice that of meat; four times that of eggs, wheat and other cereals; five or six times that of bread; twice that of other beans, walnuts and filberts; and twelve times that of milk.

There are still many divergent views among medical dietary specialists as to how people who have to practise economy can best maintain their

strength and working capacity by a balanced diet at a minimum cost.

Thirty-seven grammes of first class protein and a figure of 3,000 calories have been found necessary to supply the dietetic needs of an average working man. Food requirements vary of course in accordance with the demands for physical exertion but there is general agreement on the necessity of having a proper proportion of proteins, minerals and vitamins. In Europe and America there appears to be an ingrained belief that a certain proportion of animal protein (milk, eggs, cheese, meat or fish) is necessary. This is called "first-class protein" and is thought to represent the highest form of nutrition. But, as has been pointed out, vegetable protein as yielded by the soya bean, forms the energizing element that enables a vast number of Orientals to lead a life of hard toil with as little exhaustion as a well-fed Western labourer in a meat eating country would have.

We will now consider the uses of the bean itself as food, and prominence must first be given to the seeds (beans in the pod), which are easily stored and can be transported without deterioration while at the same time they are the ideal container for oil, preventing it from becoming rancid. It has been shown by Professor Berczeller (a known Continental authority on the bean) that the biological value of the whole soya bean seed is much higher than that of the rough flour manufactured from it. The milling process favours the development of rancidity.

Immature Green Beans. When not quite fully developed the beans make a palatable and nutri-

tious green vegetable if shelled and boiled like green peas. They can be put up in tins just like peas.

Mature Dried Beans. Because of their high fat content and compact texture most varieties of the bean are more difficult to cook than other beans and require prolonged boiling. But there are two kinds, the Easy Cook and Hahto that have been developed in America, which can be more readily boiled to softness. In China the dried beans are soaked in salted water, then roasted and eaten like salted pea-nuts. Removal of the bean skin after five minutes immersion in hot water greatly increases the speed of boiling. The addition of onions, tomatoes and other seasoning vegetables greatly improves the "brew." If the water be hard a little bicarbonate of soda, which precipitates the calcium salts, should be added. The digestibility of the beans depends largely on the thoroughness of cooking.

Soya Bean Coffee. When roasted the bean makes an excellent coffee substitute: hence one of its names—the coffee berry. This preparation gives a liquid of the same colour and almost the same odour as coffee and has a nutritive value twice as high as that of coffee. The flavour is somewhat that of cereal beverages. It is much used in America, and in Europe, particularly in Austria and Switzerland, and is marketed under the description of "Coffee Without Caffein." There is every probability that soya coffee produced and sold in the United Kingdom would have a successful future. A great advantage is its freedom from the deleterious caffein.

Soya Bean Chocolate. When combined with sugar and cocoa-butter the chemical composition, aspect and taste of the bean mixture are very closely similar to ordinary chocolate. Roasted and pulverized soya bean is now the chief constituent of many brands of milk chocolate in the United States.

Soya Bean Sprouts. These make a very favourite dish among the Chinese. In every town and village throughout China, more especially in the northern half of it, one sees tubs of tender white-stalked, yellowish-tipped sprouts being hawked for sale and finding ready purchasers. The beans are soaked in water and in a few days a crop of sprouts is germinated—a simple and clean production. They furnish a fresh vegetable dish the whole year round and form the chief ingredient of salads. These germinated beans have been proved to have considerable anti-scorbutic properties, developed during the first days of sprouting. The shoots make a delightful crisp salad of delicate flavour and are easily digested; when boiled they are a tender delicacy.

Soya Bean Milk. A milky emulsion similar to cows' milk in properties and appearance can be made by soaking the dried beans, preferably the yellow variety, in water: one part of the mash to three parts of water. The mixture is then boiled for half-an-hour. This vegetable milk is extensively used in China and Japan and has the merit of being cheaper than cows' milk. It is naturally tuberculosis-free and its casein is not so liable to form curd in the stomach. Though it can be bought in the form of soya milk powder it can

easily be made in the home, provided that attention is paid to the beans being finely crushed. Prepared in this domestic way the possibility of conveyance of infectious diseases, e.g. typhoid fever, dysentery, diarrhœa, and scarlet fever, is reduced to the minimum. Though the protein content of soya vegetable milk is similar to that of animal milk it is much higher than that of human milk. It also contains less fat, ash and carbohydrates than human and dairy milk, so it is usually prepared with sugar.

Children can be fed exclusively from birth on soya milk, but Dr. Ernest Tso of the Peking Union Medical College who has done much good work in investigating its nutritive value for infants, found that a supplementary food of cane sugar, rice starch and calcium lactate was necessary to bring it up to a milk diet of full value. In older children fed on vegetable milk the addition of one or two eggs to the daily diet enhances its vitamins A and B content, and its protein quality and protects the child against rickets.

All the time I spent in China, I was struck by the conspicuous absence of rickets among Chinese children. Recent official reports show that no less than 80 to 90 per cent. of the elementary school children of London gave evidence of having some degree of rickets.

Soya milk is not as yet generally obtainable in Great Britain. We are far behind the Orient in this matter, the more so when we reflect that it has been a staple article of diet since earliest times in Buddhist countries which do not use cows' milk at all. In December 1931, Dr. F. R. Rittinger and

Dr. L. H. Dembe published an article in the *American Journal of Disease of Children* on "Soya Milk in Infant Feeding," in which they affirm that "soya bean with the addition of sugar and mineral salts can be made an adequate food for children," and they described a method of preparation of "milk flour" made by pulverizing and spray-drying the beans at a moderate temperature, to avoid loss of vitamin value. This powder is then packed in vacuum sealed tins which prevent the development of rancidity in the product itself.

Their method would present no inherent difficulties for any commercial undertaking in this country.

The average age, when feeding with bean milk was started, was about four weeks. In almost every case the milk was well tolerated: a good average gain in weight was maintained and the general health and condition of the infant were also good.

In these days of economic stress we have in soya milk powder an article which is germ-free, of known nutritive properties and at a low cost, compared with that of dairy produce. The subject is well worth the consideration of all those who are interested in infant welfare.

One can understand that the use of soya milk could not have lasted down the ages in the Far East if it had not been found satisfactory by generations of Orientals.

Soya Bean Flour. When the whole bean (preferably of yellow variety) is crushed and ground or made into pressed cake after the oil has been removed, we get a flour which can be successfully used in making bread, biscuits, macaroni, etc. It

is necessary that the beans must first be well dried and roasted because of fatty substance.

In China and Japan the flour is usually mixed with millet, wheat or corn in proportion of one part bean-flour to three parts wheat-flour, and this mixture has a high food value with a rich nutty flavour.

Throughout China, except in more exclusively rice-eating provinces, one sees in common use lumps of steamed bread about the size and shape of an orange: this is made of millet flour, eight parts, and bean flour, three parts. It forms the staple diet of millions of manual workers and their families.

In making pastry the proportion of soya flour can be increased to one-half. In the United States, soya largely enters into the composition of many of the widely advertised breakfast foods. Although obtainable unmixed, it should be combined with the flour of wheat and other cereals because of its richness in proteins and fats in which these other flours are deficient. On the Continent the most popular method of using it is in the form of Professor Berczeller's patent flour which contains valuable fat-soluble vitamins. By Berczeller's method not only is any bitter taste eliminated but the product is made durable without harming the proteins, fat and vitamins. It is nearly tasteless and in the form of flour would be a valuable addition to our daily diet.

In Austria and Hungary, Berczeller's flour finds great favour; in fact, it has been officially adopted by the Hungarian Government under the caption of a "first-class popular foodstuff." One pound of this preparation is claimed to equal two

pounds of meat plus half a pound of wheat flour, and is of course much cheaper in price—a factor of great economical importance, for compared with animal proteins (meat, eggs) the protein of soya costs less and is easily manufactured.

In the form of biscuits it is an ideal concentrated food which can be used as a good substitute for meat preparations as it keeps well. It could thus be suitably used for army or ship rations and for explorers.

Berczeller gives its uses as follows:—

(1) As roasted flour with an equal part of wheat flour for soups or vegetables.

(2) For pastry, 10 to 15 per cent. soya bean flour is mixed with wheat flour. In this case no eggs, or only one or two, need be added. The soya flour gives to the dough a beautiful rich yellow colour.

(3) As an addition to meat, 20 to 25 per cent. soya flour can be mixed with chopped meat for balls, sausages, stuffing, etc.

(4) All sorts of flour dishes can be baked with the addition of soya flour. The taste of the dishes thus prepared becomes better and the nutritive value higher, in addition to the economy in butter, eggs and sugar.

(5) The addition of even 5 per cent. soya flour in making wheat bread causes a much longer keeping capacity of the bread in a fresh state, the fat preventing the bread from getting stale.

(6) The Berczeller flour can be used also on a large scale in the foodstuffs industry and in different ways, e.g. in the manufacturing of paste products (as a substitute for eggs), cakes, biscuit products, milk bread (10 to 16 per cent. flour instead of milk), sausages and pastry products as a substitute for meat.

In Germany the advantages of this wonder bean have been increasingly recognized during the past decade. There are large German factories which specialize in preparations made from imported soya beans, and I am kindly informed by Mr. P. F. Edwards, Commercial Secretary to the British Embassy at Berlin, that a well-known firm, the Edelsoja-Praktikum of Berlin, after scientific investigation, has adopted Professor Berczeller's flour as a regular human food and is in course of placing their methods and proposals before British firms.

German scientists, Professor Kafemann, Dr. Gossel, Dr. Bollman and Herr Ehrhorn have all invented methods of preparing flour from the soya bean by different mixtures and proportions by which the protein content and the fat-soluble vitamin could be best utilized in an economic way, with the object of replacing the expensive meat of the family diet without affecting nutrition.

By Ehrhorn's simple process the flour is made from the meal of bean cake, and its protein content is 60 per cent. higher than from the whole soya bean : it is also rich in fat. This flour can be used to make vegetable bouillon extracts which have the taste and flavour of beef bouillon—the well-known Maggi consommé cubes being composed of it. In America soya bean flour is put to manifold uses as a food material.

In Great Britain there is a bean flour produced under the trade name of "Soyolk." Soyolk is a pale yellow, finely ground powder, in texture similar to ordinary flour. If added at the rate of 4 lb. of Soyolk to a sack of wheat flour for making

wheat bread, fermentation difficulties are eliminated and the action of the yeast proceeds smoothly, giving a ripe dough so that the loaf has definitely increased volume.

ANALYTICAL REPORT ON "SOYVITA" LOAVES
MADE BY MESSRS. WM. BEATTIE, LTD., GLASGOW.
Calculated on dry matter.

	Beattie's white bread control %	10% "Soyvita" bread %	22½% "Soyvita bread %
Protein (N × 5·7)	13·36	16·65	19·88
Fat (by acid hydrolysis) ..	3·34	4·51	5·63
Crude fibre	0·51	0·75	0·97
Ash (including salt)	2·11	2·32	3·15
Ash of flour, etc. (by difference)	0·46	0·98	1·46
Salt	1·65	1·34	1·69
Total phosphoric acid (P205) ..	0·30	0·43	0·53
Lipoids (lecithin, etc.) ..	None	0·19	0·35
Cold water soluble matter deducting mineral matter consisting of sugars, etc. ..	8·40	10·70	12·90
Water soluble acidity expressed as lactic acid	0·21	0·35	0·43
Starch	71·98	64·53	57·69

"It would appear from the above figures that the control loaf contained some added fat, as the normal oil content of dry bread without added fat is about 1·4%.

"It is clearly evident that the addition of 'Soyolk' increases the ingredients of most food value, i.e. protein and fat, and also increases the most easily digested part, i.e. water soluble matter. Further, it increases the phosphoric acid and the lipoids, the latter from a quantity too small to estimate, in the white loaf, to a very appreciable quantity. At the same time that these valuable constituents are increased, the least valuable constituent, the starch, is correspondily decreased."

Soyolk in brown and wholemeal bread at the rate of 15 lb. per sack improves the eating, cutting and keeping qualities, while dryness

and crumbling do not exist. Soyolk bread is a special loaf made from a mixture of 22 per cent. Soyolk, with 78 per cent. wheaten flour, with a striking increase in food values, as compared with ordinary white bread.

Mixed with a little milk, cocoa and sugar this form of soya flour makes a palatable, easily digestible and nutritious food in all cases of lack of nutrition, convalescence after illness and digestive disturbances.

Bean Curd. This is a most popular article of diet among the Chinese. It is a veritable cheese which takes the place of meat in a land where the peasantry cannot afford the luxury of "butcher's meat." There are various kinds of it, from the white, slightly nutty flavoured curd to the richer yellow variety known as "stinking curd," which rivals a ripe Gorgonzola or Stilton cheese in odour. A usual sight as one passes through a village is a blindfolded donkey or a water-buffalo yoked to a heavy millstone, tramping round in a circle, grinding beans. The resultant flour is then cooked, made into paste, and mixed with a little turmeric to curdle it. The paste is wrapped in butter-cloth and placed in a cheese press which solidifies it. It is then cut into cubes or cakes and is ready for consumption. This cheese gives a Chinese labourer sufficient protein-energy nourishment to sustain him through a long day's toil: it forms the necessary complement to his rice, maize or millet diet.

Soy. Soya Bean Sauce. Chinese Bean Sauce. Chinese bean sauce is a dark brown salty liquid of a flavour between ketchup, vinegar and bouillon.

It is widely consumed all over the British Empire, in the form of proprietary relishes and sauces. In the East where food is eaten with chopsticks the custom is to pick up a morsel of food and dip it in a little bowl containing Soy which is on the table at every meal of rich and poor alike. Soy sauce helps the digestion for it stimulates the internal absorption of both proteins and carbohydrates. It is prepared by mixing soya beans, wheat or barley and salt water: the mixture is put aside and undergoes fermentation.

A mould develops which plays an important part in the process and breaks down the protein material into proteolytic ferments which, though they have no direct food value, are nevertheless useful in developing a pleasant flavour and stimulating the appetite. Soy can efficiently replace meat extracts, soups and other stimulants derived from animal products. In Japan manufacturers have found that soya bean cake will produce a Soy sauce of better quality at a lower cost than the whole beans. The mould, which is a mildew fungus, starts the fermentation process: it is added to the boiled beans while they are moist and warm.

According to Japanese historical literature, Soy was used at the Imperial Court 1,250 years ago, so it has withstood the test of ages as a dietary adjunct. In former days only soya beans were used as the raw material but during the past 300 years brewing processes have been improved by using wheat and a solution of salt in addition to the beans.

In the production of Soy (known to the Japanese as Shoyu) all materials are fed at first into the

selecting machine by which dust is cleared away. Soya beans are then submitted to steam pressure while the wheat is toasted and smashed by a roller. These are next mixed equally before being carried into a special yeast room where experts introduce yeast bacteria from pure cultures. A salt solution is then mixed in forming the so-called Moromi (unrefined Soy) which is kept for a year, as long as yeast fermentation is going on. During this time, by frequent stirring and aeration, the colour and characteristic flavour of Shoyu are elicited.

After being sufficiently fermented the completed Moromi is carried into a compression chamber for the purpose of squeezing out the raw Shoyu, lees and oil. The raw Shoyu is pasteurized and is now ready for marketing. It is used in Japan like table sauce in other countries. A few drops of Shoyu on grilled or fried meat or over salad greatly improves the flavour of the food without losing its original taste.

Soy has steadily pushed its way into international markets and the export of it has annually increased both in quantity and value. In England people who say they have never heard of Soy are taking it every time the red-labelled long necked bottle of proprietary sauce appears on their table. There are many firms in Japan who produce different brands of Soy (Shoyu) which differ slightly in flavour because of special brewing methods, but they are all made from the same ingredients, viz., toasted wheat, steamed soya beans, salt and water through natural fermentation for over a year.

Miso. Miso, a most popular dish in Japan, is a fermented mass of soya beans, barley, table salt and

water. It can, with the addition of boiling water, be made into a gruel, and when supped as a breakfast dish is found not only to be satisfying and readily digestible but also to have very sustaining properties for a hard day's toil. In China much the same preparation is widely used: it is called *Chiang* and *Chiang Yu*. When the popular bean curd (*Tofu*) is fermented it becomes *Chiang To Fu* —a tasty, nourishing, vegetable cheese, which if it could be introduced into this country would soon become popular.

If we can succeed in spreading the food use of soya beans in this nation of meat-eaters, it will undoubtedly be of incalculable benefit, for the bean makes it possible to supply a source of energy-yielding protein cheaper than by any other food. It opens up a prospect of great economical importance.

One has only to note on the refuse heaps in our towns the thousands of empty tins which have contained vitamin-diminished ready-cooked meats and fish to realize why our poorer classes are afflicted with carious teeth to the extent of 100 per cent. due to improper foodstuffs.

When we compare Orientals such as the Chinese (who as a race have wonderful teeth) with ourselves the advantages of a regular nourishing diet of easy digestibility and assimilation can readily be understood. For 2,500 years the soya bean has played an important part in the diet of millions of Chinese who rely on its strength-giving qualities to help them through long and arduous days of heavy manual labour.

The soya bean and the products made from it

are without doubt the most complete and natural food known to the human race. It is the most perfect body nutrient that has so far been discovered and it would repay every effort that can be made to popularize its consumption in Great Britain.

Dr. L. J. Harris, in addressing the British Medical Association at its meeting in Dublin, said that correct feeding was not a matter that could be left to nature or instinct and he stressed the point that " adequate nutrition is not possible for certain sections of the community under existing circumstances, and much scientific knowledge of nutrition already won fails to gain sufficiently wide recognition or practical application."

One half of the world does not know how the other half lives and it is due to ignorance on the part of the British public and food manufacturers that a food such as the soya bean which fulfils the body requirements of the myriad peoples of the Far East, should so far have found no general acceptance among our own people.

In February 1936, Sir John Orr, Director of the Rowett Institute for Research in Animal Nutrition and one of the leading authorities on the science of nutrition, when speaking to the Farmers' Club said that if we have the wisdom and the courage to adopt a bold and generous policy of buying health and buying a prosperous countryside by spending money on a national food policy, we shall reconcile the apparently conflicting interests of the farmer and of the poor people who must have cheap food. He claimed that much of the ill-health and poor physique among working-class families is attribut-

able to malnutrition in some degree and said that there had been a good deal of discussion lately as to whether the low consumption of these foods of special value for health is due to ignorance or to poverty. No doubt both play an important part.

There are 4,500,000 people in this country who spend on an average four shillings per head per week on food. At this rate it becomes all the more important that every ounce of food taken should have the highest possible nutritive value and herein lies the need for bringing soya food to the notice of our people. Increased soya consumption would be mutually beneficial to farmers and consumers.

Recently the Chairman of the National Provincial Bank said :—

"It has been estimated that if the undernourished classes in this country were able to enjoy a full diet there would be an increased trade in foodstuffs amounting to about £20,000,000 a year, giving revived activity to British farming without harming oversea trade or shipping."

Foodstuffs in which the Soya Bean or its Products are Used for Human Consumption.

American "Health" Flour.
Berczeller's Flour.
Biscuits.
Bread (7½% Soya Flour).
Breakfast Cereal Foods.
Buns.
Casein Gluten Flour.
Cheese.
Chinese Bread.
Chocolate.
Crackers.
Cocoa.
Coffee Substitute.
Confectionery in general.
Diabetic Foods.
Doughnuts.

Egg Substitute.
Ehrhorn's Flour.
Fermented Bean Curd.
Filled Sweets.
Green Beans.
Heudebert Soya Bread.
Ice Cream.
Infant Foods.
Lard Substitutes.
Lecithin.
Macaroni (20% Soya Flour).
Muffins.

Oils for Salads.
Oleo Margarine.
Pancakes.
Pastry.
Rolls.
Salad-Sprouts.
Sauces and Relishes.
Sausages.
Soya Bean Flour.
,, ,, Meal.
,, ,, Sprouts.

Soyolk.
Smoked Bean Curd.
Dried ,, ,,
Tinned Beans.
Vegetable Soya Milk.
,, Condensed Milk.
,, Cheese.

CHAPTER IV

SOYA BEAN OIL

Early history—Native mills and primitive processes—Hydraulic pressure—Expeller process—Solvent extraction—Solvents—Hydrogenation—Care and treatment of the oil—Census of oil mills in Manchuria and China proper—Oil shipping firms in Vladivostock and Dairen—British oil mill companies—Refined bean oil—United States oil mills — Continental mills — Transportation requirements — Edible uses — Methods of refining — Industrial uses—Illuminant, lubricant, soap, glycerine, paint-making material—Waterproof cement, artificial rubber—Development of trade in crude oil—Table of uses for industrial purposes—Mr. Henry Ford's "industrialized barn" and his method of combining industry with agriculture—Another by-product—Casein.

CHINESE historical records of over 3,000 years ago show that when the Emperor Shen Nung (the Chinese Father or God of Agriculture) first gave directions that the wild soya bean plant should be cultivated, he was aware of its oil yielding properties; so that oil expression is practically contemporaneous with cultivation of the bean. There are ancient Chinese pictures which show in their scenes of village life the grindstones used in crushing beans.

A number of native mills in Manchuria and China still keep to the age-old primitive apparatus for extracting oil. The millstone grinds the beans into a thin paste, which is placed in gunny bags and steamed over a small vat of boiling water till it has become heated and saturated with steam. The contents of the bags are then emptied into round iron frames, five of which are placed one

above the other in a vertical press made of four upright beams, with cross-beams at the top and bottom.

Pressure is applied by means of wedges driven in between the cross-beams, and the resultant oil drains down into a receptacle. It is a wasteful method in that only about 40 per cent. of the oil present in the beans is squeezed out of them. Moreover, the steamed bean cakes in their moist condition are apt to become mouldy and the process is a slow one, which requires considerable hand labour in loading and unloading the presses.

Though there are many places in China where one can see these native mills carrying out this process, most of the large Manchurian bean mills are now equipped with modern machinery able to extract a greater quantity of oil.

In addition to the old hand-worked presses there are three processes: (1) Hydraulic pressure, (2) the expeller machine and (3) solvent extraction.

Hydraulic Pressure. The beans are crushed and steamed and the oil is squeezed out of the mass by hydraulic power, which extracts about 5 per cent. more oil in a quicker way than by manual labour.

Expeller Process. This is most generally in use in the United States. It is a continuous pressure method in which the oil is extracted by "expellers." After being crushed and dried, the bean mass is heated to 150 degrees Fahrenheit and passed into the pressing cage of the expeller machine, which operates on the same principle as a domestic meat grinder and with a fairly high pressure of six tons to the square inch. In this way

the oil is uninjured and retains its vitamins. One ton of beans will yield by this process thirty gallons of oil and sixteen hundred pounds of meal, the difference (about 170 lb.) representing the loss due to cleaning and the evaporation of moisture driven off after the beans have been crushed.

Solvent Extraction Process. When first imported into the United Kingdom, soya beans were dealt with in our oil mills by the same methods as those employed in crushing linseed and cotton seed. But it was found that the bean was a little difficult to treat in the ordinary machinery and required considerable extra care to get the right result. During recent years the matter passed beyond the reach of the ordinary crushing trade and became, to use a technical expression, an "extraction proposition." There are now very few mills in Great Britain or the Continent that produce bean cake and oil by simple crushing. Nearly all British mills are extraction factories. Bean cake finds a market as a valuable feed by dairymen and poultrymen, and the resultant oil is used as a refined oil for edible and industrial purposes in this country, while the exportable surplus is chiefly sent to non-European markets.

By the subsequent extraction process the oil is dissolved out from the beans with benzol, ether, carbon disulphide, chloroform, acetone or by a special high test gasoline, after the beans have been well cleaned and finely crushed. The oil is then separated from these fat-solvents by distilling off the latter. This distillate can be used over and over again. In well-operated plants no trace of the solvents is left.

Oil obtained by this method possesses superior bleaching qualities and shows less refining loss. It is a clear, pure fluid, very different from the thick dark brown oil of the older pressure process. The bean residue, which is said to contain no detectable trace of the solvent, is less susceptible to rancidity and shows better adhesive properties for utilization in the glue industry. Though solvent extraction plants are the most costly to install, they are more economical to operate than the hydraulic or expeller plants.

Hydrogenation. Japanese research workers at Dairen in Manchuria have developed the method of hydrogenation which hardens the bean oil into natural fat. The liquid fatty acids of oils are combined with atoms of hydrogen, of finely divided nickel or palladium, and are thus converted into solid fatty acids which can be used instead of the oil itself.

This process possesses the great advantage that, if done in Manchuria, the hardened, hydrogenated oil can be shipped without loss by leakage, which is sometimes a serious cause for complaint, as liquid oils are notoriously prone to leakage during transit. Many of the vegetable oils, including soya bean oil, require hydrogenation before they can be used for making edible products or the harder soaps and it is possible to vary the degree of hydrogenation according to the use for which it is intended, e.g. as a substitute for lard and butter, for soap or for candle manufacture.

The care and treatment of soya oil has developed into a highly technical business and is the subject of constant chemical research.

In Manchuria, prominent among the institutions in which this research work is carried out, are the South Manchurian Railway Central Laboratory at Dairen under Japanese direction, and the Laboratory of Agricultural Chemistry of the Chinese Eastern Railway at Harbin. Most of the mills have their research departments.

A recent census taken in Manchuria gave the total of 754 oil mills. Of these mills 405 were situated in South Manchuria and 68 in North Manchuria. In North-East Manchuria an investigation made by the Chinese authorities showed that there were 281 oil mills located in that part.

In China proper there are, according to the most recent figures, 119 oil mills in the provinces of Kangsu, Hupeh, Shantung, and Hopei, with a very few, seven in all, in various other provinces. This does not take into account the many small individual mills. The product of these Chinese mills is almost entirely for local consumption. It is to Manchuria that China looks to supply most of the soya beans, bean cake and oil that it consumes.

The modern technique followed in these Manchurian mills is due to Japanese initiative, and this also is the case with mills in Korea and Japan, which produce immense quantities of bean oil. One has only to visit Dairen, for instance, to see the scientific way in which many problems connected with oil production have been investigated in order to understand the high standards which have been obtained. The finished product can now be exported so as to conform to any standard required.

Japan, curbed from colonial expansion, is developing industrialization at a rapid rate: she is permeating Manchuria with these intensive methods, and by them has succeeded in gaining control of the greater part of the Far Eastern soya trade.

At Vladivostock and Dairen the following are the principal bean and oil shippers:—

The Anglo-Chinese Eastern Trading Co. British.
Louis Dreyfus and Co. British.
Anglo-Soviet Shipping Co., Ltd. British and Russian.
Ye Fa Ho Oil Mill Co. Japanese and Chinese.
The Chinese Asiatic Co., Ltd. Danish.
Mitsui Bussan Kaisha. Japanese.
The Lido Company of Mukden. Japanese and Chinese.

In England the bean oil trade is carried on by the following firms:—

The British Oil and Cake Mills Ltd., the ordinary shares of which are held by Lever Bros., Ltd., so that they are a branch of Unilever, Ltd.
The Hull Oil Manufacturing Co., Ltd., Hull, now merged in the foregoing concern.
The Premier Oil Extracting Mills Ltd., Hull.
Messrs. Wray Sanderson & Co., Hull.
The Medina Refinery Ltd., Deptford, London.
Messrs. J. Bibby & Sons Ltd., Liverpool.
The Erith Oil Works Ltd., Erith.

Refined Bean Oil. The most important part of our oil mill industry in England is concerned with converting the crude oil into suitable media for the many uses to which it will be put.

When the crude oil is mixed in an ethyl alcohol

solution and heated, and the mixture then allowed to cool, the oil separates out, leaving the free fatty acids in solution. Crude oil can also be refined by using sodium hydroxide, which neutralizes the free fatty acids and eliminates colouring matter. The separated oil requires to be clarified, bleached and deodorized before it can be said to be refined.

Bleaching is done by mixing the oil with 10 per cent. clay, which results in the dark brown crude product being converted into a light yellow oil. Deodorizing is done by blowing superheated steam through the oil *in vacuo*.

In the United States there are large expeller and extraction oil-refining plants in Delaware, Illinois, Indiana, Iowa, North Carolina, Missouri and Virginia, which are the principal soya bean producing areas. The East North-Central group of States is by far the leading group.

California, Nevada and Washington report practically no production.

A great part of the processed oil is sold on contract through vegetable oil brokers in Chicago. The National Soya Bean Oil Manufacturers' Association of that city has trade rules which show the careful way in which marketing problems are being approached in present day oil dealings. These rules deal with quality, off-quality, quantity, time of shipment, rejection and brokerage. Their whole soya oil trade is now highly organized.

On the Continent large oil extraction plants have been erected in Germany, which has ousted the United Kingdom during the past six years from the monopoly of the trade. There are also extrac-

tion works in Holland and Denmark, which retain the bean cake for cattle and poultry feed, and export the oil, a good deal of which we purchase.

Soya bean oil requires careful handling during transportation, as it is liable to changes in specific gravity, in colour, acidity, taste and unsaponifiable matter. In order to arrive at its destination in good condition its moisture content must be low and it has to be shipped in as pure a condition as possible.

In the United States, shipments of crude soya bean oil are only permitted with up to two per cent. free fatty acids and two-tenths of one per cent. moisture and impurities. Unless properly stored, rancidity sets in. On arrival in England this oil is taken in hand by our oil refineries.

Having now generally considered the production of bean oil we can proceed to deal with its uses as an article of food and trade.

Food. The oil has three important edible uses—either as lard substitute, in margarine or in cooking and salad oils. It is principally employed in the Far East in the preparation of meals: from every restaurant as one passes along the streets, there issue odours of savoury messes dropped into frying bean oil. The poorer classes use it in the crude state but for the better-off people it is clarified by being boiled and allowed to stand. It is an easily digested oil because it contains linolic and linoleic acids which are constituents that are known to be readily assimilated.

When the beans are hydraulically pressed or dealt with by the expeller process the fat soluble vitamins are retained in the cake and the oil is deprived of them, but by the extraction process the

reverse is the case: the vitamin is dissolved out with the oil and there is none left in the cake, so that by solvent extraction the oil is made available as a nourishing ingredient for oleo-margarine and vegetable butter, which have the same consistency, at room temperature, as dairy butter.

Modern methods of refining, deodorizing, decolouring and hydrogenating, have greatly extended the edible uses of soya oil. It can now take its place as a first-class substitute for the more expensive salad and vegetable oils and animal fats. If a certain amount of animal lard be added to partly hydrogenated hardened bean oil, it makes a perfect lard.

A favourite dish throughout China is bean curd (tou-fu) fried in bean oil, and in other countries it is now coming into extended use as a frying oil for meat, fish and vegetables and as a fresh vegetable oil of the right consistency for salad dressings.

Industrial Uses. It is when we come to commercial demands that we find the largest outlet in this country for the utilization of soya bean oil. As the value of the oil has become recognized, new uses and new markets have been found and the trade in it will continue to increase in importance now that it has been found to compare so well with other vegetable oils. Scientific technical processes have linked up with industry in producing an oil of superior quality which is capable of being industrially used in very many ways.

Illuminant. The refined oil burns brightly in lamps. For a number of years it has been used all over the South Manchurian railway system in signal lamps, also on the railways in Japan.

Lubricant. Bean oil requires a vehicle in the form of a mineral or hydrocarbon oil before it can be used for lubricant purposes. Such a mixture is specially suitable for low temperatures and can be applied as an axle grease in railway wagons and cars. As it is a drying oil it cannot be used alone as a lubricant, for the fatty acids which it contains, in common with all the other fatty oils of animal or vegetable origin, harden when exposed to air. Superheated steam will decompose the oil into glycerine and one or more fatty acids.

Soap Manufacture. Because of its frothing powers and other qualities soya oil is specially adapted for this purpose and more so in Great Britain than in America where coco-nut, linseed, palm, palm kernel and peanut oils still hold sway, chiefly for hard soaps such as the better-known kinds of toilet and laundry soaps.

The bean oil is saponified in the form of free fatty acids, and by means of hydrogenation the unsaturated fatty glycerides become converted into components of the hardened hydrogenated fats.

With proper saponification methods an excellent soap can be produced. The saponifying process is facilitated by an admixture of tallow, coco-nut oil and rosin in varying quantities and by using five per cent. caustic soda lye when the oil is hot.

When sodium is the salt base, hard yellow soap is the result : when potassium is the base soft transparent soap of darker hue is made. In making hard soap, water glass should be added for hardening. By using starch the lustre is improved. Soap makers generally buy soya bean cake which they break up and by using extraction solvents such as

have been already mentioned, the oil is dissolved out. In the Unilever Soap Factory in Japan this is the process employed: their popular Sunlight Soap contains a good percentage of saponified bean oil. Hydrogenated bean oil with tallow (25%) will yield a soap which will lather in hard water and by this same method a soap can be made which will lather in sea water.

If bean oil be mixed with castor oil a soap of great frothing power can be made and it is specially good in soft or distilled waters.

Pure soya soap is best employed in the hard water which is common throughout China where the water supply of towns and villages is got from shallow wells.

A very fine hard curd soap is made by mixing together palm kernel oil (50% of the whole), lard (15%) and soya bean oil (35%). This is a yellow soap which can be made white by the addition of hypochlorite solution.

Generally speaking the saponifying power of bean oil is as good as that of all other important oils and fats, with the exception of coco-nut and palm kernel oil which possess higher saponification index numbers, while its price is lower than that of the inedible fats of animal or vegetable origin. This latter factor brings an increasing demand for it as a toilet soap or for hospital and laundry soaps, and, where potassium is the lye, for a good commercial soft soap in which it can be entirely substituted for linseed oil as a soap basis.

Glycerine. Bean oil will yield about ten per cent. of glycerine which can be further distilled or refined to become the pure glycerine used in the

making of nitro-glycerine for explosives. It is obtained by the action of caustic soda or superheated steam on the oil. A soap is formed from the fatty acids and glycerine is set free.

Paint-making Material. Soya bean oil has considerable drying properties which fit it for acting as the oily ingredient or vehicle for paints. When used for this purpose a great deal depends on the quality of the refined oil. The power of drying is the ability to combine with atmospheric oxygen and this in turn depends on the degree of saturation of the fatty acids in the oil, for the less they are saturated the more quickly will they combine with oxygen and become dry. The drying quality of the oil means of course its power to become hard and dry more quickly, instead of remaining a sticky oily surface able to smear ones clothes. Oil of this latter kind usually requires a notice of " Beware of Wet Paint!" This drying ability is technically measured under the term " iodine index," which refers to the amount of iodine which an oil will absorb. It is by noting this percentage of iodine that the drying capacity can be estimated. In linseed oil the iodine index number is 185 : in soya bean it is 125. The lower index of the latter means that it has somewhat less drying power than linseed oil and so its index number must be raised. This has been shown in America to be possible by breeding varieties of the bean which will yield better quantity and quality, for there are strains of the bean which have high or low lines of quality as measured by the iodine number. It is in America that most investigations have been made on the utilization of soya bean oil paints.

Though in that country they produce 42,000,000 bushels of flax annually, they have to import 19,000,000 bushels of flax, from which they get linseed oil and cake. It is being found that bean oil and cake are efficient substitutes and can successfully compete not only with linseed but with cotton seed oil, the latter of which has only semi-drying properties.

About 37,000,000 lb. of soya bean oil are annually produced in the United States and 25 per cent. of this total goes into paints and varnishes of very high quality. Both corn oil and cotton seed oil have a lower iodine index number than soya bean oil and they therefore need more adjustment in the process of combining them with paint. Although soya oil does not have quite as good drying properties as linseed oil, it has the advantage of flowing more freely, working better under the brush, and of producing a glossy film which has far more elasticity.

The smooth flowing qualities and the elastic film produced make soya bean oil particularly desirable for use in enamels, and large quantities are used in that way in the United States. Soya oil has another advantage over linseed oil in that it does not tend to turn yellow with age. This property makes its use in brilliant white paints and enamels specially applicable.

There is ample ground in England for more development of such processes in which the oil can be employed.

Waterproof Cement. Waterproof cement is made by mixing a watery emulsion of saponified bean oil with cement, plaster of paris or mortar. The water

gradually evaporates, leaving the mixture hard and dry, and absolutely resistant to any further permeation of water. This important quality is the result of a combination of various products in the oil with colloidal elements in the cement, the gradual desiccation of which results in a waterproof hardening. Moisture-resisting cement prepared in this way has many uses, e.g. for tunnels, bridge piers, artificial stone, drainage pipes, hatchery ponds and floors, in fact for any works in which seepage of water must be prevented. The saponified oil keeps steel rods in reinforced concrete from becoming corroded and it is resistant to sea-water. It is claimed that it is much cheaper than any other waterproof of the kind and retains its original power permanently. It would appear that cement users are beginning to recognize this valuable anti-seepage property of soya oil for there is a gradually increasing demand for it in works which for their stability require to be proofed against any incursion of water.

Artificial Rubber. Pioneer chemical research by two German scientists, Grosse and Sauer, over a period of twenty years, showed that by emulsifying and heating a mixture of 100 parts bean oil with 40 parts nitric acid an elastic material could be produced which could be moulded to any shape or form; but though this artificial rubber can withstand pressure its elastic properties will not bear stretching. It can thus not replace natural rubber, but it can reduce porosity, and by so doing increase its resistance to permeation by light and air and prolong the period before decomposition sets in. In this way, it can be usefully employed for electric

cable insulation, water tubes, floor mats and the waterproofing of various goods as an addition to, but not as a substitute for pure natural rubber.

Soya bean oil is used in the production of printing ink. It makes a good and permanently consistent vehicle for holding the dye stuffs in suspension, and in the manufacture of linoleum, in which it is an even more suitable medium for paint ingredients than the linseed oil from which linoleum takes its name. When hardened by hydrogenation and mixed with a proportion of tallow it makes excellent candles. In the Orient it is used for the basis of the wonderful lacquers that are made there. In Japan it is used by manufacturers of celluloid articles. It can also be employed as a fuel oil for domestic purposes, but kerosene and petroleum amply fill the world's needs in this respect, and are produced in such quantities that they can be sold on competitive terms that are lower than the cost of processing bean oil to make it fit for being placed on the market as a commercially profitable fuel.

Both in Manchuria and America the scientific and industrial study of soya bean oil is being intensively made. Much research work is going on and the use-values of this product are steadily extending.

The crude oil shipped from Manchuria is a most important factor in our trade, for it gives employment to our oil mills which refine it and return it to China in the form of soap, candles, glycerine, margarine, and all the other articles mentioned in the course of this chapter, that are manufactured by means of highly developed technical industries.

Board of Trade returns show an increase in imports of raw materials with a consequent improvement in our export trade. It stands to reason that the more crude oil we import, the more chance will we have of developing the trade in our exports to China, that vast Oriental market which is annually requiring more and more of the comforts in modern life that can be got from our industrial products.

The claims which have been made for a more extended use in Great Britain for soya bean oil are in no way suppositions: they are well founded and are the outcome of practical application following research along industrial avenues.

Our demand for the oil is still too individualistic. By the concerted effort of a central organization the trade would be lifted out of its present compartmented lines. Without any doubt there is ample room for expansion of a kind that would prove itself remunerative to all those concerned.

Uses of the Soya Bean for Industrial Purposes.

Artificial Petroleum.
Automobile Steering Wheel Rims.
Cable Insulator.
Candles.
Casein.
Celluloid.
Core Oil.
Crude and Refined Oil.
Electric Distributor Parts.
Emulsifier.
Enamels.
Floating Soap.
Foundry Sand-Cores.
Frying Oil.
Glycerine.
Glue.
Hard Curd (Kennel) Soap.
Hard and Soft Soaps.
"Horn" Buttons.
Hospital Soap.
Illuminant (for Lamps).

Lard.
Laundry.
Linoleum.
Lubricant.
Oil Cloth.
Paints.
Paper.
Photographic Films.
Plastic Material.
Printers' Ink.
Potassium Soap.
Rubber Substitute.
Sea-water Soap.
Shampoo Mixture.
Silk-scouring Soap.
Silver Soap.
Soy Vinegar.
Textile Dressing.
Toilet Soap.
Transparent Soap.
Varnish.
Waterproof Cement.

This chapter would be incomplete without drawing attention to the active and far-seeing soya work done in America at the instigation of the automobile magnate, Henry Ford. Taking as his basis the Co-ordination of the Farm with Industry and facing the question of how the American farmer could increase his income, Mr. Ford has found the answer in showing farmers how they could manufacture on the farm, or in a nearby village, products which industry will buy in the form of a basic farm material that would be commercially profitable. For some years past Ford has taken a great interest in the potentialities of the soya bean and has over 8,000 acres of it yielding approximately 100,000 bushels per annum on his farms at Michigan. From this cultivation, he has evolved products for such uses in the making of automobiles as enamel, foundry sand-cores, horn buttons, steering wheels, gear-shift knobs, distributor parts, light switch assembly and timing gears. He and his experimentalists have shown how an ordinary farm barn can be industrialized by the installation of simple

machinery mostly made out of standard piping obtainable at small cost. By this means the beans can be broken up and the oil extracted in marketable form on the farm. The process is direct and rapid. Soya beans, after threshing, are stored on the upper floor of the barn where the heat rising from below helps to dry them.

Directly under an opening in this floor is a set of rollers, so placed that the beans feed into the rollers by gravity. The rollers flatten the beans into thin flakes and they then pass into the extractor.

This is a pipe fixed at 10 degrees angle to the floor and filled with a solvent which is generally a high test gasoline or naptha. The bean flakes are fed into the bottom of the pipe by a screw conveyor acting like the Archimedes worm. As the thin flakes work upward against a constant stream of gasoline, practically every bit of oil is removed from the bean and mixes with the gasoline. The flakes, after considerable contact with the solvent, move on up in the form of meal, to the top of the pipe, where they leave the solvent chamber and drop into a steamer where the solvent which the meal has soaked up is vaporized and driven off by a current of steam.

The meal leaving the steamer is granular in form and has no trace of the solvent odour. Meantime the gasoline, fed in at the top of the pipe, works its way down, against the meal, along the flanges of the screw, carrying the oil with it. At the bottom of the pipe is an upright piece called the "neck." When the oil-laden gasolene reaches the bottom of the pipe, atmospheric pressure forces it up into the

"neck" from which it overflows, leaving the extractor and carrying all the oil with it. Distillation then turns the gasoline into a vapour which rises, passes through a cooling apparatus, is condensed back into the form of gasoline and flows back into the top of the pipe which forms the solvent chamber.

Thus it serves its purpose as a solvent again and again, the whole process working continuously. The distilling apparatus is simple. The gasoline flowing from the "neck" is first put through a filter which removes all particles of meal. Then it is run into the still which consists of a 12-inch pipe, 16 feet long, the upper 10 feet of which are filled with coke. The solution, flowing over the coke, meets a rising current of live steam, which drives off the solvent and only the pure soya bean oil remains at the bottom of the still. When the machinery is in operation there are about 100 gallons of solvent in the system flowing continuously in a closed circuit. As every seam and vent is closed, except one, there is very little wastage of gasoline and very small fire hazard. By this process 2,000 lb. of beans yield about 400 lb. of oil and 1,600 lb. of meal.

In the method employed by the Chinese, when they had removed the oil they used the cake for human and cattle food, but Mr. Ford has devised a much more profitable use for it. He has started a new industry in which the oilfree meal is going to be one of the principal raw materials in the formation of "plastics." It is a plastic which, under pressure, moulds very solidly and can be finished smoothly so as to take a high polish. This

new plastic industry offers immense possibilities Radio cabinets, flooring tiles, table tops, buttons, spools and shuttles for the textile industries, ash trays and cigarette holders are but a few of the hundreds of things that are being made to-day with plastic materials and for which soya bean meal could be made to serve admirably. I make no excuse for having detailed at some length the oil production machinery introduced to American farmers under Mr. Ford's initiative and aegis for it opens a vista of practicable achievement among British Agriculturists without necessarily upsetting the interests of our oil milling trade, which can do much with the crude oil so obtained. While many farmers might not see their way to individually install the machinery that has been described, it would be quite feasible if the co-operative principle were adopted. By this method groups of farmers could combine in the formation of a district "industrialized barn" to which they could send their beans for oil extraction and marketing, receiving back the bean cake for their own disposal —feeding cattle and poultry and for fertilizer. Much of Denmark's economic success in the production of pigs, butter and cheese has been due to the establishment of district mechanized creameries to which the farmers send their milk, from which butter and cheese are made, and receive back the skimmed milk that is fed to their pigs with successful results.

The oil extraction machinery for the proposed farm factories is, as has been said, far from costly. The distilling apparatus is made of sheet metal suppliable by any tinsmith. A piece of special

equipment is the filter which is a conical tank fixed half-way up the extractor pipe: it is of welded construction. The crushing rolls are the only items as such that have to be purchased, aside from the few pipe fittings and other accessories. Power is developed by a boiler and steam engine. The plant could be set up in any community regardless of the power supply available. Coal, wood, oil or other fuels could be used. The boiler would require to be equipped with a steam super heater. Simple though this apparatus may be, the Edison Institute in America is working on a plan to make it even simpler.

There are vast possibilities in this scheme which would undoubtedly bring agriculture and industry closer together. For our farmers it should be what our American cousins call a "paying proposition." Nothing of the crop need be wasted. Even the shredded stalks of the plant can be used industrially as fibre for making boxes, pressed board, wall materials, also as fuel and in the making of certain chemicals such as furfural. Most of the initial processes of manufacturing these by-products can be done on the farm or in the district farm factories.

In the words of Mr. Ford:—

"Anything that can be grown to provide industry with manufacturing materials will bring new revenues to agriculture and will help to raise the prices of the old-line conventional crops: and, just as in industrialization, will eventually double the purchasing power of the farmers, so it will likewise directly increase industrial activity and employment."

We are still, in England, far from perfection in our

methods of employing farm products profitably and "the plight of the farmer" is a commonplace expression which even the activities of our Marketing Boards have not dispelled. For the combining of industry and agriculture in soya production we will require organized co-operation which is an important essential.

Casein. This is one of the most important by-products of the soya bean. Up to the present practically all the casein employed in industry is made from cows' milk and, having regard to the multifarious outlets for its use, the supply is hardly equal to the demand.

Casein is the principal ingredient in that wide range of bakelite and artificial horn substances which stand so high in modern favour. It is because of casein that the compound is bright, durable, non-brittle, able to stand hot water and to be easily moulded in addition to forming excellent insulating material. It is also employed in making photographic films, glues, soap, paper, varnish and in the preparation of various medicines.

Few manufacturing countries are able to produce enough milk to furnish all the casein they require and have to import it in large quantity. The U.S.A. annually import over 30,000,000 lb. of milk casein to meet that country's needs.

Vegetable casein which, like milk casein, is a nucleo-albumin, can be made from the bean and it is chemically almost identical with the milk product but with the advantages that it can be made more cheaply and that it has only 0·5 per cent. of ash as against 4 to 8 per cent. of ash from milk casein.

In the production of soya casein from the beans

or bean cake the solvent extraction process must be employed as it is necessary that casein should not contain more than 0·3 per cent. of oil.

When made from bean cake the residue still contains sufficient salts to make it a good fertilizer.

Professor M. Tarle, Ph.D., of the Moukden Arsenal Laboratory, in writing of the subject in the *China Journal* said :—

"For the present, casein is still obtained from cows' milk which contains 2·5 to 3·5 per cent. of this substance. Casein is a horny substance, in the pure state almost transparent but usually turbid on account of minute particles of fat. In water it swells up but does not dissolve. However, it readily dissolves in alkalies and combines with many chemical products. Pre-eminently essential for technics is its capacity for combining with formalin. A further important property is its easy absorbability by the human organism, a property employed in medicine to introduce with its help such substances as iodine, which by themselves cannot be absorbed by the system. The well-known patent medicine 'Sanatogen' is a mixture of casein and sodium glycero phosphate."

There are no special technical difficulties about the manufacture of casein from soya beans but in order to make it on a paying basis it requires production on a big scale and this necessitates the installation of a large plant. There is, however, such a great demand for casein that the whole output would be readily absorbed by the market.

CHAPTER V

THE SOYA BEAN TRADE

History—The inland and coastal trade—Lack of enterprise — Immigrant peasant farmers — Japan takes an interest—The beginnings of exportation to Europe—America enters the field and expands her production—Present state of the trade—The chief exporting countries—Vladivostock and Dairen, ports of shipment—European oil mill preferences—Dramatic increase of American output—Import duty—Fluctuations in prices—Japan's control of the trade—Transportation and its difficulties—Progress in different countries—Manchuria still chief source of the bean—Limits of the trade not yet reached—Suggested British National Soya Association.

A Retrospect: How the Trade Arose.

MANCHURIA has for centuries depended on the export of soya beans for its prosperity. It was a purely coastal trade, the cargoes being taken by picturesque junks for consignment to ports along the China Sea littoral.

The history is an interesting one.

From the far north, the region of the Upper Sungari River, right down the length and breadth of Manchuria, over rough trackless wastes and deeply rutted roads, lumbering carts drawn by teams of mules, donkeys and sturdy Mongolian ponies toiled for long distances with heavy loads of the bean-cake and oil; the latter contained in oil-paper lined willow baskets.

The journey was curtailed whenever possible by carting the loads to the nearest waterway where

river junks could bring the consignments down to the port of Newchwang and from there they were borne south by sea-going junks. The chief demand for bean cake came from Chinese sugar planters who required it for fertilizing their cane fields, and the oil was used as a substitute for pea-nut oil. The reason for this demand was that nowhere in China, south of the Great Wall, are the beans of such good quality as those grown in Manchuria.

It was an unenterprising, steady trade, which showed no tendency to expand, largely because of Chinese Governmental restrictions that operated against the emigration to Manchuria of peasant farmers, growers of the bean, who crossed the Gulf of Pechih-li from the well populated province of Shantung, or tramped northward from Chihli province.

It was not until the year 1870 that the Imperial Chinese Government, which up to that time had kept the bean trade within their own coastal limits, removed the embargo against foreign ports and export shipments to Japan began. Growth and production entered into a more flourishing phase with the appearance of steamers which ousted the junk traffic and enabled larger cargoes to be taken from Newchwang. Restrictions against farmers and coolies from North China were removed and they flocked by the million into Manchuria.

These men are among the finest agricultural types of the world and they settled down with a will to work their small holdings of three acres and a donkey.

The stream of immigrants steadily pushed northward until now they are to be found spread all over

From "The Vegetarian News."

A view of Dairen (Dalny), in the Kwantung peninsula, showing vast quantities of the soya bean awaiting shipment.

Manchuria—a peaceful penetration. Some forty years ago Japanese merchants began to turn their attention to the vast possibilities of this Land of Promise.

The use of bean products became very popular in Japan with a consequent increase in demand and a further fillip was given to the trade in the years following the Sino-Japanese War of 1894, which China lost and had as usual to pay for by making concessions.

Towards the end of the 19th century, Russians came upon the scene. In their descent upon Manchuria they penetrated down to Dairen, searching for an ice-free port to the Pacific Ocean. They made strenuous efforts by building huge stone wharves to develop the port and attract shipping to it. But they overdid their activities, and in 1904 the Russo-Japanese War ensued which resulted in Japan's ascendancy over the Kwangtung Peninsula.

Dairen soon became in Japanese hands a formidable rival to Newchwang, which had hitherto been the great exporting centre of the trade.

A new period now set in—the era of exportation to Europe. Up to 1908 China, Japan and Korea had consumed the whole of the bean production, but in November of that year the well-known Japanese firm, Messrs. Mitsui and Co., made a big and satisfactory shipment to England, the first British steamer chartered for this purpose being the "Titan," a cargo vessel of Messrs. Alfred Holt & Co.'s Blue Funnel Line. In the following year, when the value of the bean and its oil had become known, 400,000 tons were exported to

England. Messrs. Lever Brothers were the first foreign firm to appreciate the saponifying qualities of the oil and to enter the market as purchasers of it for the manufacture of Sunlight Soap. The general progress of the trade now began to be placed on a firm basis.

Manchuria's youthful rival in the growth and production of soya beans is America. In the space of one generation this latter country has entered the lists as a competing exporter in a striking way, as we shall see from the following short retrospect of her soya bean story.

In 1890 some United States farmers took up the production of soya crops, though for a number of years previously it had been grown on a limited experimental scale.

During the next twenty years the increase was scarcely serious: the potential virtues of the bean as a crop were not generally recognized.

In 1909 no State gathered as much as 50,000 bushels. Ten years later, in 1919, Virginia produced more than 100,000 bushels and North Carolina approached 500,000 bushels.

By 1924 Illinois, North Carolina, Missouri and Indiana raised more than 1,000,000 bushels each.

Iowa, in 1929, had reached a figure of 500,000 bushels, Indiana 1,000,000 and Illinois 3,250,000 bushels, and in 1931 the total production of soya beans in the United States had grown to 15,000,000 bushels, a quick and gigantic increase when we consider that it was not until two years after Messrs. Mitsui's first consignment to England that the United States began importing the oil and that up to 1916 she was still importing beans from Manchuria.

Present State of the Trade.

America would thus appear to have recognized the bean's commercial possibilities. In 1933 that country had 3,950,000 acres devoted to soya cultivation: in 1934 there were 4,223,000 acres and in 1935 this soya area had increased to 5,463,000 acres. All the time new avenues of bean utilization are being explored.

By 1931, so marked had been the progress in the home cultivation of the bean that, after satisfying her own needs, America found herself in possession of an exportable surplus. Since that year this trade has annually continued to swell in volume.

Manchuria, Korea, Japan, America and the Dutch East Indies are, in the order named, the five chief exporting countries, though Manchuria, the Land of the Bean, far exceeds them all, in fact it produces two-thirds of the world's crop.

In the Far East the two ports of shipment are Vladivostock and Dairen. The latter ships ten times more in quantity than the former. Tariff barriers, unfair discrimination and heavy port dues have greatly interfered with business from the Soviet port.

The trade is in the form of beans (consigned to oil extraction mills in Europe) bean cake and oil. Of recent years European millers have shown a greater tendency to import the beans in bulk for crushing in their own countries, selling bean-cake residue for cattle feed. At the same time there is evidence of a growth in demand for bean oil in its crude state.

Though there may be a saving in freightage of

the more valuable oil when the crushing is done in Manchurian mills, there is a consequent diminution in our importation of bean cake, retained by the Chinese for farm and stock purposes.

In 1931 Manchuria exported 2,206,000 tons of beans to Europe and other countries, but in 1932 this amount, because of the depression, had fallen slightly to 2,204,000 tons. In 1933 it was 2,292,747 tons and much the same the following year, viz., 2,289,905 tons; in 1935 the total export had fallen to 1,166,276 tons, largely because of lessened demand from Germany owing to her economic troubles.

The price of beans reached its lowest level in Dairen in March, 1934, namely £4 17s. 6d.—a fall from 1928, when it had realized £12 2s. 6d. per ton.

Bumper crops in Manchuria occur periodically and cause fluctuations in price. An interesting feature of the almost dramatic American increase in figures arose from low levels of prices for wheat and maize in 1931 and 1932, which made the farmers find it to be more profitable to devote attention to the growth and production of soya beans.

During 1931 the total shipments of the bean from the United States of America were 3,500 tons; in 1932 this had risen to 112,700 tons and the average price realized was £7 6s. 3d. per ton, which was on a higher level than in 1931, when it did not rise above £6 8s. 9d. per ton.

In 1932 the British Government decided in the interests of the trade not to impose import duty on soya beans which up to that time had been included

in the List of Dutiable Goods. The 10 per cent. burden was found to be hampering the subsequent exportation from our oil refineries and the removal of this tax had the effect of stimulating demand for more beans by British crushers.

The increased British demand found its echo in the higher price asked by shippers in Manchuria. The United States at once took advantage of the turn in affairs to make free offers of American grown beans, with the effect of causing a market drop of 15s. per ton. Later on, notwithstanding American competition, the market improved 10s. per ton, and it was noticed that American soya beans were being offered to a less extent as the exportable surplus of the crop was getting exhausted, for the American farmers were realizing the importance of soya beans as pasturage for their cattle and would not spare for export more than a part of what they grew. The influence of tariff on a commodity has been well exemplified in the United States bean trade.

Prior to 1921, soya bean oil, meal and cake were on the Free Market List, but in that year a small duty of 20 cents per gallon of oil was imposed. The following year the duty on bean oil was reduced to 18·75 cents per gallon and a duty of 30 cents per bushel was levied on soya beans without causing noticeable change in the importations.

But in 1930 the duty on oil was increased to 26·25 cents per gallon, and on beans to $1.20 per bushel, while bean oil, meal and cake were taken from the Free List and given a duty of $6 per ton.

The result was that the importation of all soya

raw products promptly declined and the various States responded to the impetus received by increasing their production of the bean. This protective tariff, of course, greatly helped American farmers, millers and exporters. Their case, however, as producers is a very different one to that of the British market, which is wholly concerned with importation and not with production.

In 1935 the British policy of freedom from import duty was reversed and the Chancellor of the Exchequer imposed a duty of 10 per cent. on all soya bean importations.

The bean trade fluctuates, as every other trade does, owing to sudden causes which cannot be foreseen.

Thus a decline in the sterling rate of exchange combined with reports that heavy floods in Manchuria had washed away stocks on the river banks and caused extensive damage to the growing crop caused prices to rise sharply in the early autumn of 1932. It was stated that over 100,000 tons of soya beans had been washed away and that from ten to forty per cent. of the crop had been damaged.

In consequence of all this, the price per ton rose from £6 7s. 6d. to £8 7s. 6d. and the United States again took advantage of this temporary dearth to enter the market and sell considerable quantities at competitive prices.

During the world depression European crushers experienced considerable difficulties in finding buyers for their meal. This, combined with prospects of large shipments from Manchuria, caused prices to fall further : they fell then to £7 per ton.

At this time also, shippers had trouble in securing freight, the rates having risen from 20s. to 32s. 6d. per ton.

Though soya bean imports to Great Britain have increased, our figures have hitherto been far below those of Germany. But in 1934 the German Government issued instructions to oil millers to temporarily cease purchasing certain oilseeds including soya beans. This cessation of German buying had the effect of causing a fall of 5s. per ton. Denmark imports a greater quantity of beans than England. Denmark uses the bean cake and meal to feed the pigs and poultry required for her huge consignments of bacon and eggs to our shores, and exports most of the resultant oil.

Figures talk, and it will serve to show Denmark's appreciation of the advantages to be gained by the importation of soya beans if we compare her 1931 importation, 238,062 tons, with 110,194 tons imported by Great Britain. In 1935 the respective totals were 260,101 for Denmark and 158,979 for the U.K. There is here food for thought. Of the leading European countries, France is the smallest importer; her soya demands are nearly one-third less than those of the Netherlands. The foregoing observations have been chiefly concerned with beans. Now let us deal with the oil.

In 1931 Dairen and Vladivostock shipped 79,381 tons of this by-product to Europe.

During 1932 shipments from these two ports fell to 35,646 tons; in 1933 it was 34,425 tons and had risen in 1935 to 64,495 tons. In addition, from six to eight thousand tons of oil are annually exported from Japan.

The average price per ton of oil c.i.f. was greater during 1928 than in subsequent years : seven years ago it was £32 15s. per ton : during 1935 it was £21. For beans and bean oil alike prices during the last two years have not been remunerative to the producers considering the heavy transport charges to the coast and increased ocean freights. At its present level soya bean oil is very cheap and attractive for edible and industrial purposes and under normal circumstances purchasers can buy in Manchuria at the same rate as the Chinese. There is always a good demand from Mid and South China.

In this connection it is worthy of note that, apart from the shipments to Europe, Dairen and Vladivostock export large quantities of oil to China.

Japan has now become the leading controller of the trade and has displaced China. Japan, moreover, is a neighbouring market and her extensive use of the bean, combined with her research work and commercial acumen are factors which have fostered the trade.

When England in 1908 received the first big consignment that had ever been sent abroad the foreign trade in soya beans was at her feet, but that position has not been maintained. It was a short-lived monopoly that has vanished. Even Holland every year since 1919 has imported larger quantities of the bean than the United Kingdom.

As we have not yet reached the point of successful cultivation on a commercial scale in this country we must continue to look to Manchuria and the Continental market and the United States to supply our needs, at any rate for some years to come.

The American entry as a producer makes a new factor in price control and ere long she will become a more important competitor as the disparity between the dollar and sterling exchange lessens.

Manchuria is undoubtedly the chief source of the world soya trade and our European demands have largely contributed to her economic development. The average annual income of Manchuria from the sale of soya beans to China and Europe is £18,000,000.

In 1931 Manchuria exported 134,000,000 bushels of beans, cake and oil and America's export of her crop for the same period was 980,325 bushels, most of which was sent to Germany.

The cost of milling is higher in the United States than in Manchuria, Japan, Germany or England. Beans are produced by the Manchurian Chinese farmer at less than one-third of the price asked by the American farmer.

Handling, transporting and processing the beans in the United States are all heavy enough to make remunerative production in that country a somewhat difficult business if it is to be kept on a competitive level with world prices. But, as acreage increases and exportable surplus expands, American production costs will diminish.

While a few years ago soya beans fetched £13 a ton, the extracted oil £35 a ton, and bean cake £12 a ton, present day prices, as have been shown, are little more than half these figures, partly due to the world crisis but chiefly because there has been little advance in the exploitation of the many uses to which the bean and its by-products can be put. Lack of use means lack of

demand and so the saturation point of supply is more readily reached and prices fall.

Our British mills deal chiefly with the imported Manchurian beans from which they extract 18 per cent. of oil; they use the imported crude oil for refining.

One ton of beans will yield 250 lb. of oil and 1,600 lb. of meal: the loss of 150 lb. is due to the moisture content and to other milling shrinkage.

After satisfying our own demands we export the surplus refined oil, most of it going to Far Eastern ports. If our farmers would take more of the bean cake from the mills for cattle feed, the trade would be in a better condition and cattle would be nourished at less cost than by other feeding stuffs.

With regard to shipping by British steamers, consignments are regularly carried in ordinary stowage and, generally speaking, the method is quite satisfactory, if attention be paid *en route* to ventilation. The British shipping record is every bit as good as that of Continental and Japanese steamers for safe carriage of perishable cargo. Bean oil is brought in bulk and bean meal and cake as filling cargo. Occasionally our milling companies have complained of rancidity in the oil, or of mould in bean cake, or of overheating of the meal, but such occurrences are now rare.

The bugbear of rancidity by which soya bean oil loses its characteristic taste and odour, and acquires flavours peculiar to rancid fats and oils in general, is due to fungus moulds which in their growth split up the fatty elements that are among

the constituents. These fungi are active only when the export oil is stored in a humid state and has a moisture content above 2·5 per cent. Removal of the moisture by filtration stops the destructive activity of the fungi and isolation of the oil from air stops the growth of the fungus mycelium.

Dry-filtered oil will safely endure two years storage. The responsibility of avoiding rancidity in cargoes rests with exporters in seeing that only dry-filtered oil is shipped.

The industrial chemist's watchful eye is more necessary in the organic vegetable oil trade than in that of the more stable inorganic mineral oils.

Ventilation, because of moisture in bean cake, is the most important factor in sea transportation: a mouldy cargo is unsaleable in the European markets. But there is, as a rule, very little risk of degenerative changes taking place nowadays during transit on board ship. In all well-organized lines special engineer officers are in charge of ventilation and refrigeration to maintain stable conditions that will prevent any change taking place in perishable cargoes.

In order to find relief from irksome Japanese control, arrangements for a time were made by Chinese merchants to send bean cargoes to Leningrad and then ship them from there to North Europe and England. Consignments by this route take a shorter time and have arrived at Hamburg in perfect condition: it is claimed, doubtfully, at a cheaper rate of freightage than by the sea route.

But political conditions under Soviet rule are too unstable to allow of this rail route becoming a serious factor for some good time to come. The

Chinese Eastern Railway route is too much the child of international bickering between Russia, Japan, Manchukuo and China to be reliable. For British importers the hold of a British steamer is the best and safest method of transportation from Manchuria.

In Czecho-Slovakia a stage has been reached where soya crops are grown in sufficient quantities to allow of an exportable surplus. But high transport and tariff charges make the price on arrival in England prohibitive. It is greater than that incurred for the long voyage from Manchuria. The best beans grown in Europe emanate from Czecho-Slovakia—they compare favourably with first-grade Yellow Mammoth American soya beans. Canada is cultivating a substantial acreage of the beans but supplies are taken up entirely for Canadian consumption.

The same observation applies to other parts of our Empire, like South Africa, where good progress in production is being made. In Argentina, where large quantities of flax are grown for linseed oil production there was, in 1931, a marked diminution, only half the usual quantity of linseed being available. This gave an impetus to the cultivation of soya beans, the oil being recognized as a most effective substitute for linseed oil.

But, after all these geographical considerations, we have still to regard Manchuria as the principal source of the soya bean trade, and there is every indication that it will continue to be so. Climatically, agriculturally, economically, no other country in the world is a more suitable terrain for the production of this bean. The three provinces of

Manchuria cover an area of 364,000 square miles, i.e. three times the size of Great Britain and Ireland. About 55 per cent. of the cropland is devoted to soya beans which account for over half of all the country's exports.

Up to 30 per cent. of the total crop of nearly seven million tons remains in Northern Manchuria to supply the local demands, leaving 70 per cent. for export. Of this exportable surplus China proper absorbs the larger part, so that there are left about two and one-quarter million tons of beans for Europe.

As yet there is no organized soya bean exchange market in the United Kingdom: the bean has up to the present time not got beyond the stage of a departmental market in our National Seed Crushers' Association.

The quantity brought into the United Kingdom is as follows:—

Year	Tons
1930	105,559
1931	110,194
1932	158,938
1933	157,489
1934	177,194
1935	158,979

For the same period the importation to Germany was:—

Year	Tons
1930	894,790
1931	998,595
1932	1,168,360
1933	1,152,466
1934	899,242
1935	507,714

which proves that Germany has become well aware of the importance of the trade even though her purchasing powers under her present financial state have temporarily fallen away.

The biggest importation to the United Kingdom was in 1929 when the total reached 205,022 tons.

Though our mills receive nearly all of their supply direct from Manchuria our buyers are ready to purchase any American bean consignments that may be available at a trifling difference in price, according to the market position at the time.

The American quality runs lighter in oil percentage than that from Manchuria, consequently there is generally a slight difference in market price.

In proportion as soya bean utilization extends in the United Kingdom, so will demand for stability in the production increase on a basis of grade.

As far as Manchurian producers are concerned there is room for more care in ensuring good quality of the bean and more definite price quotations.

There is so far little ground of common interest between Chinese producers and British traders. Our soap makers and other users of the bean and its products are content to buy in the open European market without any reference to source of supply, so long as price and quality are to their liking.

The whole trade in soya beans is far from reaching its limit. It is such a popular article throughout the Far East that there will always be a large enough production and consumption to

make the trade worth while even though European demand does not increase. Manchuria is the Canada of the Orient and could easily stimulate its production if necessary.

Satisfactory selling prices contribute to the prosperity of millions of Chinese peasant growers, most of whom lead a life of enforced frugality but whose needs for the comforts of modern civilization are becoming more marked.

There are already signs of this, as instance the spread of electric lighting, telephones, machinery, cigarettes and matches. It means a larger demand for our industrial exports. Although Japanese research workers at Dairen have made scientific studies and industrial surveys of the bean and its oil, and notwithstanding the fact that Manchuria is such a huge producer, there is yet little advance in China in the art of processing, i.e. the manufacturing of articles by modern machinery from products of the bean. Perhaps this is just as well for the balance of trade is kept more even by the interchanges that take place.

We buy the beans and crude oil, and turn them into soap, candles, glycerine, paints, biscuits, etc., which we export to China. It is an overseas trade which can stand expansion.

There is room for better organized methods of meeting Manchuria's potential, as well as actual, needs.

Every year our buyers repair to Australia for the wool sales: these men are experts in their special line and as such are able to handle the trade on expert lines. They deftly examine the quality of the wool and quote prices based on competitive

production and demand. Sometimes these quotations are satisfactory to Australian wool growers and at other times they are far from being remunerative. But the buyers are always able to buy at keen competitive prices owing to their intimate knowledge of the wool market.

A similar system could be made practicable in the soya bean trade by the inauguration of a British National Soya Association. Such a body could undertake the work of making propaganda (as by exhibitions) that would result in increased use of the many valuable edible and industrial products that can be made from the bean. The trade, as it stands, requires co-ordination and this can be better obtained under the ægis of a central authority than by any other method.

From "The Vegetarian News."

Top:—Hoeing and ploughing a soya-bean field in Manchuria.

Bottom:—A trainload of soya-bean cake at Dairen.

CHAPTER VI

THE SOYA BEAN IN AGRICULTURE

Limited British experience and demand—Some uses—Beans, hay — Pasturage — Silage — Straw — Soilage — Forage—Poultry fattener—Soil improvement—Pests—No diseases—Work of the U.S. Government Experimental Stations—*The Times* article on pig breeding—Feeding wild deer in America—Drought-resisting qualities.

BEYOND purchasing a limited amount of bean cake our farmers have little experience of the more general use of the soya bean, which occupies a place of much greater importance in the agriculture of other countries than our own.

It might therefore be well to complete the record of the bean's usefulness by showing how it is employed on the farm for livestock and other purposes.

Soya Beans. Soya beans can be fed whole or cracked or ground, or mixed with corn, oats or peas.

Soya Bean Hay. In Manchuria, America and Czecho-Slovakia the hay is used for dairy and beef cattle, horses, sheep and swine. Its principal value lies in the high content of digestible protein, and this makes it particularly valuable for feeding dairy cattle. It is equal to red clover or alfalfa for milk and butter production. The one objection to soya hay is that it has coarse woody stems, but this can be overcome by early cutting, a point that could easily be met in England, for in this country,

with its short summer, the bean pods do not always come into maturity until late in the season. But hay crops of the right tenderness could be produced if cut before the plant is fully ripe. The best time is when the pods are formed but few of them are filled. At this time the plants are heaviest and contain most protein. By delaying the harvest the woody stems become less palatable.

Pasturage. When harvesting is interfered with by weather conditions, lack of labour or other causes, such as shortage in other perennial pastures, the soya plant is found to furnish a very satisfactory pasturage for all kinds of live stock, especially if supplemented with a corn ration. In the United States a favourite method is to plant the beans in alternate rows, or mixed and drilled in the same row with corn. This makes a fine general pasturage for sheep and pigs.

Silage. A well-balanced silage which is readily eaten by cattle is made by mixing one part of soya beans with two parts of corn. Experiments have shown the marked superiority of this mixture to that of corn silage alone.

Straw. Threshed soya straw makes a good dry roughage for all kinds of live stock. The use of straw is naturally only applicable in countries where the bean is grown and where the straw can be used by stock farmers in the locality.

Soilage. This term applies to fresh green roughage. By planting at different dates farmers are able to arrange a succession of green forage throughout summer and autumn. The soya plant is palatable at all stages of its development and thus makes an excellent soilage crop.

Forage. A mixture of soya bean hay and silage.

Soya Poultry Fattener. In the Pacific Coast States poultrymen have held soya meal in much favour for a number of years and consider it an especially good feed for flesh and egg production. It is necessary that it should be supplemented with a suitable mineral mixture as the bean meal (like any other vegetable protein meal) is somewhat deficient in calcium, phosphorus, sodium and chlorine. These minerals can be supplied by adding bone meal, limestone or oyster shell for the calcium, bone meal and rock phosphate for the phosphorus and common salt for the sodium and chlorine. The proportions of a very good egg-producing mixture are composed of sixty parts bone meal, twenty parts ground limestone, and twenty parts common salt; these are well mixed together and one and a half pounds of this mixture are added to five pounds of soya meal. A food which has been found very suitable for chickens is a mixture of equal parts of soya meal, wheat shorts and cracked corn moistened with milk.

In poultry feeds the bean as a source of concentrated protein gives as good results as the animal protein supplied in meat scraps.

Poultry, and the value of poultry-produce have greatly increased in recent years. Until lately hens and pigs on the farm were regarded as side lines. Now the case is different. Hundreds of farmers have given poultry a prominent place among their livestock. Piggeries, also, are springing up all over the country.

There is not a tithe of the demand that there should be from British poultry keepers, for either

bean cake or the crushed oil meal. Our farmers could, with profit to themselves, take up all the bean cake that is produced in British oil mills and leave none of it to be exported to the Continent, as is now the case.

Bean cake has four times more protein and eight times more fat than wheat, while it is produced at a lower cost than wheat. If the freshly made bean cake be crushed into meal and roasted, its taste, digestibility and keeping capacity are greatly improved.

Manchurian farmers use the cake freely for cattle feed and fertilizer, but they have to put up with a coarser article containing impurities such as sand and grit, because the beans are not first thoroughly cleaned as is the custom in European and American oil mills.

Those who buy bean cake should remember that it is necessary to mix the meal (crushed cake) with an equal weight of some such cereal as wheat or barley in order to avoid the digestive troubles that may be caused in their cattle from the high protein content which, unmixed, would be rather too rich a nourishment.

Generally speaking, pressed bean cake is preferable as a feed, to the untreated soya bean, especially in the case of pigs where, owing to the high oil content in the beans, the animals get too fat, and soft pork is the result. The broken up cake, fed in sufficient amount to balance corn, does not produce soft pork.

Another point in stock raising is that bean cake is more palatable and produces more gain in weight than the whole beans. The best use of

whole soya beans with pigs is for brood sows during gestation and suckling time, and it is always preferable to cook the beans before adding the feed to the troughs. A good all-round pig-fattening winter ration is as follows: Three parts by weight of maize meal, two of brown pollards, three of barley meal and one of red bran. To this mixture add one part of ground-up soya bean cake and two pounds of mineral mixture to each cwt. of meal mixture.

In countries where the bean is cultivated, farmers find it highly useful for soil improvement. This depends on how much of the plant is returned to the soil.

In Kansas, U.S.A., it was reported that there was an increase of 14 bushels of corn to the acre where corn followed soya bean in alternate years, as compared with corn grown continuously.

In China the use of soya beans, in the form of meal scattered over the ground, is popular in sugar plantations and rice plantations and for mulberry trees as a fertilizer, principally because of its value as a source of nitrogenous nourishment to the leaves on which the silk worms feed.

Harvesting for Oil. The best time is when the chlorophyll (green colouring matter) has gone from the plant. The greatest amount of oil is formed in the last two weeks of maturing.

Pests. Soya comes nearer to being pest-free than any of the common farm crops. In Manchuria there are visitations of grasshoppers which periodically arise in dense numbers and eat all the green vegetation that comes into their view. In the United States, grasshoppers, blister beetles,

Mexican bean beetles and green clover worms are about the only serious pests affecting the bean. There are no other known pests of the crop, though occasionally insects are found on the plant.

Rabbits are very partial to soya bean and markedly so while the plants are young and tender. A curious feature is that these animals show a variety preference. Some varieties of beans have been much destroyed, others partly damaged, while some were not touched.

Diseases. There are no reports of diseases of any economic importance having attacked soya plants.

In England the difficulties of soya cultivation on a wider scale will be overcome by experience and agricultural science; we are now at the stage of finding the best variety for maturing within the limits of an English summer and placing our farmers in possession of a crop of major importance.

Not only for its soil building qualities, but as a pasturage and hay crop and for seed production, from which bean cake and oil and other by-products can be made, the cultivation of soya beans is worthy of all the encouragement that can be given to it. It opens a prospect of remunerative agriculture.

But no great advance in the growth and cultivation of the bean in this country is to be expected until a concerted effort on an organized basis is made by the Ministry of Agriculture and until Experimental Stations are officially installed in different counties.

So far, the work has been left in individual

hands, and to various agricultural colleges and County Local Authorities, and those efforts have been too sporadic and non-continuous.

United States Government Experimental Stations have been most assiduous in their research for varieties of the bean that would be suitable for different kinds of soil and other conditions, and their work has been rewarded by the growing response shown by farmers, and a steady increase in the amount of acreage devoted to soya bean cultivation.

The Times, in its issue of September 18th, 1933, published an article on the "Feeding of Bacon Pigs. Some Considerations for the Farmer."

Among other points it noted that:—

"The inefficiency in feeding and management, and ignorance of the proper factory weights and grades, have really more to do with the losses in pig production in this country than a deficient supply of the right kind of pig. Of the fundamental points in pig-feeding, *the one most commonly ignored is the importance of protein in the ration.*

"Fish meal is a rather expensive source of protein and so vegetable proteins have come to be more generally employed in recent years. Of these, extracted soya bean meal seems to give the most satisfactory results. . . . For pigs being fed for slaughter over about three months of age it is sounder to use vegetable proteins, particularly as found in extracted soya bean meal, but in this case the mineral balance must be carefully watched. These pigs probably give best results fed inside and on wet food, rationed according to their weight.

"To get the general principles of sound feeding adopted by the bulk of pig producers is the not

inconsiderable task of the technical service of the Pigs Market Board or the Pig Industry Development Board."

The above article would appear to corroborate what has previously been written in this chapter on the advantages to be gained from a better knowledge and a freer use of soya meal by our farming community.

During the extraordinary cold winter at the beginning of 1934, I was interested to note in the American Press, that in the snow-bound fastnesses of the New York State forests, herds of deer had shown signs of starvation and that measures had been devised by the Animal Nutrition Laboratory at Cornell to feed these animals. Weeks of experimentation resulted in the issue of cakes containing 55 parts of soya beans and 45 parts of molasses, each cake weighing 50 lb. The food was tried out first on young fawns, then on goats, then on full-grown deer, and the cakes were suspended from trees.

Drought-Resisting Qualities. Owing to the fact that in dry seasons the roots of the plant penetrate deeply into the soil it will survive periods of drought which would wither the more shallow rooted crops such as oats, wheat and other small grains. In the United States, drought is usually accompanied by swarms of chinch bugs which devour the grain seeds that lie near the surface. Experience has shown that when a farmer finds himself faced with the impending disaster of withered crops and perished cattle feed he can save the situation, even up to mid-summer, by planting soya beans, which will provide nourishing hay for

his cattle. Prompt action—the ploughing under of dried-up oats and wheat, followed by planting of soya seed—will turn the failure into success. Moreover, there is a ready market for all the beans that can be produced.

In springtime planting may be delayed for three or four weeks if the season be a wet one. Adverse weather conditions interfere with the best growth of large soya crops. During 1934 floods considerably damaged the Manchurian crops and caused a diminution of soya exports from that country.

In America the following descriptive terms for the size of seeds are standard:—

	Seeds per lb.
Large Seed	Less than 2,000
Medium Large Seed ...	2,000 to 3,000
Medium Seed	3,000 to 4,000
Medium Small Seed ...	4,000 to 5,000
Small Seed	More than 5,000

CLASSIFICATION BY LENGTHS OF LIFE PERIOD.

Early (Very) ...	Maturing in 80 to 90 days
Early	Maturing in 90 to 100 days
Medium (Early)	Maturing in 100 to 110 days
Medium ...	Maturing in 110 to 120 days
Medium (Late)	Maturing in 120 to 130 days
Late	Maturing in 130 to 150 days
Late (Very) ...	Maturing in more than 150 days

The five groups of Beans are Yellow, Green, Brown, Black and Mixed.

ADDENDA

(1) Soybean Products exhibited by the American Soybean Association.

(2) Recipes.

(3) Statistics.

(4) India.

(5) Bibliography.

SOYA BEAN PRODUCTS IN THE UNITED STATES OF AMERICA.

The following list shows how the uses of the soya bean are spreading in the United States.

It will be noted that the exhibition was held under the fostering care of an association specially assembled to propagate the knowledge of the cultivation of the bean. If such an exhibition could be convened in this country it could not fail to stimulate interest in the subject. It would introduce manufacturers of the products to the public. At present few people know where these products can be obtained.

Soybean Products and the manufacturers who exhibited them at the Annual Meeting of the American Soybean Association in Washington, D.C.

All the products listed below are made, wholly or in part, from soybeans.

The exhibit also contained some 200 soybean products, mostly foods, brought from the Orient by Mr. W. J. Morse, Senior Agronomist, Department of Agriculture, Washington, D.C., U.S.A.

American Lecithin Corporation, Atlanta, Georgia.

Lexin.
Farinette.
Chocolate Bars.

Archer-Daniels-Midland Company, Box 603, *Milwaukee, Wisconsin.*

Pure Old Process Hydraulic Soybean Oil Cake.
Pure Old Process Hydraulic Soybean Oil Meal.—Pea size.
Pure Old Process Hydraulic Soybean Oil Meal.—Fine Ground.
Pure Old Process Hydraulic Soybean Oil Meal.—XXX Fine.
Expeller Soybean Chips.
Expeller Soybean Oil Meal.
Clarified Raw Soybean Oil.
Excelsior Non-Break Soybean Oil.
Superb Varnish Soybean Oil.
Snow Flake Heavy Bodied Soybean Oil.
Amber Raw Soybean Oil.
Scientific Pale Boiled Soybean Oil.
XX Refined Soybean Oil.
ZYMO Soybean Oil.
Ink Oil Soybean Oil.
Soybean Fatty Acids Soybean Oil.

Armstrong Paint and Varnish Works, 1318-42, *Kilbourne Avenue, Chicago, Illinois.*

Soybean Oil Prepared Paint (white).
Soybean Oil Prepared Paint (silver grey).
Big Ten Soya Oil Soap.

Battle Creek Factory, Battle Creek, Michigan.

Saucettes.

The Blanton Company, St. Louis, Missouri.

Refined Non-Break Soybean Oil.
Raw Soybean Oil.
Refined Edible Soybean Oil.
Refined Bleached Non-Break Soybean Oil.
Liquid Pine Oil Soap.

Cereo Company, Tappan, New York.

Soybean Gruel Flour.

The Davies-Young Soap Company, Dayton, Ohio.

Buckeye Cleanser Potash Soap.
XX Special Potash Soap.
Diamond A Potash Soap.
Pearl Hard Soap.
Buckeye Vegetable Oil Soap.
Buckeye Pine Liquid Scrubbing Soap.
Buckeye Sassafras Liquid Scrubbing Soap.

Detroit Graphite Company, Detroit, Michigan.

Soya Bean Varnish.

Eastern Health Food Stores Association, Washington, D.C.

"Manchu" Soybean Milk.

Funk Brothers Seed Company, Bloomington, Illinois.

Soybean Oil Meal.
Soybean Oil Cake.
Super-Soy, a mineralized soybean oil meal.
Dry Lauxein Soybean Glue.
2-Ply Insulating Board glued with Lauxein.
3-Ply Gum Panel.
5-Ply Fir Panel.
Soybean Flour.
Raw Soybean Oil.
Non-Break Soybean Oil.

Harshaw Essential Foods, Inc., 1945, *East 97th Street, Cleveland, Ohio.*

Vi-Zoy.
Lettizoy.
Soybean Spray-Dried Flour (so-called milk).

Keystone Macaroni Mfg. Co., Lebanon, Pennsylvania.

Macaroni.
Noodles.
Spaghetti.
Vermicelli.
Diabetic Food.

Kloss, Jethro, Takoma Park, Maryland.

Fresh Milk.
Pumpkin Pie (soybean milk and soybean flour).
Soybean Cheese.
Soybean Bread (20% soybean flour).
Soybean Buns.
Soybean Sprouts.
Soybean Cake.

Laucks, I. F., Inc., Box 488, *Bloomington, Illinois* (*home office—Seattle, Washington*).

Dry Lauxein Soybean Glue.
Fir Plywood glued with Lauxein.
Philippine Mahogany Plywood glued with Lauxein.
3-Ply Fir Plywood glued with Lauxein.

Madison Food Company, Madison, Tennessee.

Vigorost.
Cheese.
Soybeans canned with Tomato.
Soybeans canned plain.
Dixie Fruit Crackers.

Mead Johnson and Co., Evansville, Indiana.

Sobee.

Oriental Show-You Co., Columbia City, Indiana.

Show-You Sauce.

Paintcraft Co., The, 963, *S. Henderson Street, Galesburg, Illinois.*

Special House Paint.
Barn Paint.

Prince Macaroni Mfg. Co., 207-215, *Commercial Street, Boston, Massachusetts.*

Vita-Roni (Elbow Style).
Vita-Roni (Spaghetti Style).

Purina Mills, St. Louis, Missouri.

Cresol Disinfectant.
Purina Turkey Growing and Fattening Chow.
Purina Lay Chow.
Purina Egg Chowder.
Purina Breeder Egg Chowder.
Purina Fitting Chow.
Purina Rabbit Chow.
Purina Chick Growena Chow.
Purina 34% Cow Chow.
Purina Chowder.
Purina Bulky Cow Chow.
Purina 24% Cow Chow.
Purina Pig and Hog Chow.
Protena All Mash Starting and Growing Feed.

Shellabarger Grain Products Company, Decatur, Illinois.

Soyflake Flour.
Special X Flour.
Soybean Oil Meal.

Soyex Company, Inc., Nutley, New Jersey.

Soyex Flour.
Pound Cake.
Salad Dressing.
Chocolate Drink (containing Soyex).
Health Cookies.
Sugar Cookies.
Bread.

Staley Sales Corporation, Decatur, Illinois.

Soybean Meal.
Soybean Meal—Pea Size.
Health Flour.
Varnish Soybean Oil.
Raw Soybean Oil.
Light Edible Soybean Oil.
Dark Soybean Oil.

The Stamford Rubber Supply Company, Stamford, Connecticut.

Brown Factice.

Dr. Roy Monier, President, Board of Managers, State Hospitals, Jefferson City, Mo.

Bread.

United Drug Company, Boston, Massachusetts.

U.D. Vita-full.

Vi-tone Company, P.O. Box 356, Hamilton, Canada.

Soybean Malter Milk.
Chocolate Malter Milk.

Woolsey Paint and Color Co., C. A., Grant Merseles and Colden Streets, Jersey City, New Jersey.

XX Refined Soybean Oil.
Clarified Soybean Oil.
Superb Soybean Varnish Oil.
Snow Flake Heavy Bodied Soybean Oil.

Bureau of Chemistry and Soils, Department of Agriculture, Washington, D.C.

Pound Cake (30% soybean flour).
Angel Cake (20% soybean flour).
Sugar Cookies (50% soybean flour).
Ginger Snaps (50% soybean flour).
Bread (15% soybean flour).

RECIPES.

There have been three reasons which have kept the soya bean from becoming a popular food among European peoples.

The first and most obvious was ignorance of the existence of the bean and of where to procure supplies. In very few shops outside London (and in only a minimum number there) can soya food be purchased.

The second, a lack of knowledge of how to cook beans so that they would be soft, tender and palatable.

The third, that there is sometimes a somewhat bitter taste, but this bitterness is not in the bean itself only in the meal and flour when these have been allowed to get damp. The same bitterness occurs in oatmeal which has been kept for some time and become stale.

But ways have been found by food manufacturers to overcome these drawbacks, and to make the product durable without harming its proteins, fats and vitamins. As the soya bean is cheap and the methods of refining not costly, soya flour is within anyone's reach. When we remember the considerable proportion of water-soluble vitamin B that is present, we know that we have a valuable addition to our diet. Whereas animal proteins (meat, eggs) are dear, soya proteins are correspondingly cheap. The vitamins of soya surpass the fat of pigs and closely resemble those of butter.

It was estimated by Dr. Arnold Baumgarten of Vienna that one kilogram (2 lb., 3 oz.) of soya flour, "Soyolk," equalled two kilograms of beef or 68 eggs or 12 quarts of cows milk. Another Viennese Professor, Dr. Durig, in an essay on "The Soya Bean As Foodstuff" said that:

> "By introducing soya into the people's food a feat has been accomplished of incalculable significance, since it makes it possible to supply a source of protein as cheap as never attained by any other food. Not only in the question of feeding the people at large but also—and that in a very special degree—with regard to supplying Soyolk for public institutions, children's homes, hospitals etc., prospects of great economical importance are opened up."

It is however among diabetic patients that the high protein content and relatively small carbohydrate content of soya bean make it specially suitable for their food preparations.

Diabetes is a disease in which the human organism is unable to deal properly with starch and sugar in quantities

sufficient for the body's needs. And it is a curious fact that diabetic patients often suffer from an almost overwhelming desire for sweet foods containing a high degree of carbohydrates in spite of the dietetic rules so scrupulously prescribed by the doctor in his desire to limit the appearance of sugar in the urine.

To aid those who do not know where to procure bean supplies, I would mention the names of two leading firms of food manufacturers—with whom I have, incidentally, no commercial connection—who make the flour and who also incorporate it in various preparations. They are:

Soya Foods, Ltd., Rickmansworth, Herts.
Dietetic Foods, Ltd., 124, Victoria Street, London, S.W.1.

The former specialize in Soyolk which is flour prepared on the principles laid down by Professor Berczeller: it is a mealy powder, fatty to the touch.

The latter firm are the sole distributors in Great Britain of the well-known " Heudebert " Dietetic Food products, a French concern which makes different kinds of diabetic breads.

In America the increased demand for soya beans has made them more easily procurable for home consumption, and a Government Department, the Bureau of Home Economics, has officially published a large number of recipes.

A great variety of recipes have been invented which incorporate green beans, dried beans, and the flour. There are now enough to warrant the publication of a Soya Cookery Book.

I append a few methods of preparation to illustrate the various ways the bean products are employed.

Soybeans, Southern Style.

2 cups cooked soybeans.
2 cups corn (tinned).
2 cups tomatoes (tinned or fresh).
4 tablespoons grated cheese.
2 teaspoons salt.
½ cup buttered breadcrumbs.

Put alternate layers of the beans, corn, cheese, and drained tomatoes into a greased baking dish. Mix the salt with the juice drained from the tomatoes and pour over the mixture. Cover with the buttered bread crumbs, and bake in a moderately hot oven for 30 minutes, or until the crumbs are brown.

Soybean Salad.

1½ cups cooked soybeans.
½ cup diced celery.
½ cup diced cheese.
½ cup carrot cubes.
1 teaspoon finely minced onion.
¼ cup French dressing.

Mix the ingredients with the salad dressing. Chill thoroughly and serve on crisp lettuce.

Roasted Soybeans.

Roasted Soybeans are somewhat like roasted peanuts in flavour. Soak the beans overnight. Boil them for one hour in salted water, spread in a shallow pan, and roast in a moderate oven. Sprinkle them with salt while still warm.

Soybean Croquettes.

½ cup milk.
1½ tablespoons flour.
2 cups soybean pulp.
1 cup breadcrumbs.
1 cup chopped celery.
1 egg, beaten.
2 cups fine dry breadcrumbs.
Salt and pepper to taste.

Make a sauce from the milk and flour and combine with the other ingredients. Shape the mixture into croquettes, dip in the beaten egg, and roll in the crumbs. Fry until brown in hot fat. Curry powder may be used to vary the flavour. This mixture may also be made into a loaf and baked in a moderate oven for 40 minutes.

Soybean Soufflé.

3 eggs.
3 cups hot soybean pulp.
2 teaspoons chopped onion.
1 teaspoon salt.
Pepper to taste.
2 tablespoons finely chopped parsley.

Beat the yolks of the eggs and add them to the other ingredients. Fold into the well-beaten whites of the eggs. Heap the mixture lightly into a greased baking dish. Bake in a very moderate oven, for about 20 minutes or until set. Serve immediately.

Stuffing for Baked Fish.

oz. suet.
oz. breadcrumbs.
oz. Soyolk.
tablespoon chopped parsley.
yolk of egg.
tablespoons milk (or more).
Good pinch of mixed herbs.

Mix all very well together and use for stuffing haddock. Can also be used for stuffing lamb or game.

White Sponge Pudding.

oz. flour.
oz. Soyolk.
oz. sugar.
oz. margarine.
tablespoons breadcrumbs.
teaspoon of baking powder.
egg.
Pinch of salt.
A little milk.

Cream the margarine and sugar very well, sift the flour, Soyolk, baking powder and salt together, and add with the beaten egg alternately, beat well, add the crumbs and a little milk. Put into a well greased basin, cover with greased paper and steam in one inch hot water very gently for 1½ hours.

This pudding can be varied in many ways. The grated rind of 2 oranges or 2 lemons can be mixed in. Two tablespoons of jam or golden syrup can be put at the bottom of the basin. It can also be flavoured with almond or vanilla essence.

Shortbread.

oz. flour.
oz. Soyolk.
oz. margarine.
oz. butter.
oz. sugar.
Pinch of salt.

Cream the fat and sugar together, add flour, Soyolk and salt sifted together and work in. Turn on to a lightly floured board and knead very well until smooth. Shape into a round. Put on to a greased and lightly floured baking sheet, mark the edges with the little finger, prick with a fork and bake slowly. Can be rolled thinner and cut as biscuits.

Madeira Cake.

10 oz. flour.
2 oz. Soyolk.
8 oz. sugar.
5 oz. margarine.
2 oz. butter.
3 eggs.
2 teaspoons baking powder.
3 tablespoons milk.

Cream the fat and sugar until very light and soft. Sift the flour, Soyolk and baking powder together, add 1 egg and a tablespoon of flour and beat in very well and do the same with the other eggs. Fold in the remainder of the flour and milk. Put the mixture into a tin well greased and floured, and bake in a good moderate oven.

Soya Soup à la Reine.

1 oz. Heudebert soya flour.
15 oz. meat or vegetable broth.
½ oz. fresh cream.
½ teaspoon arrowroot flour.
1 egg yolk.
Pinch of salt.

Mix the soya flour, cold, in a third of the broth. Bring the rest of the broth to the boil. When that is done pour in slowly while stirring, the broth previously prepared. Cook on a slow fire in an uncovered vessel for 15 to 20 minutes. Add salt sparingly, on the completion of the cooking. Bake the yolk of egg in the bottom of the receptacle in which the soup is to be served; mix the fresh cream with the egg and pour over it the soup cooled to 140° F. Then mix the whole. Do not bring to the boil for the egg would be coagulated and give the soup an unpleasant appearance. If desired, add some quite small crusts of bread, buttered.

Soya Chocolate.

1½ oz. soya flour.
½ oz. soluble cocoa.
1 teaspoon arrowroot flour.

Mix all these preparations carefully, mix in a little cold milk 1 tablespoon of the powder. Bring to the boil the quantity of milk necessary for a breakfast cup and add it slowly stirring, to the paste previously obtained. Cook on a low fire until it begins to boil. Sweeten according to taste.

Soya Vegetable Soup.

½ oz. butter.
1 teaspoon soya flour.
½ teaspoon lentil flour.
½ teaspoon arrowroot.
½ pint water.
½ pint milk.
Pinch of salt.

Dilute with cold water the mixture of soya flour, lentil flour and arrowroot, then pour the paste thus obtained into the boiling milk, continuing meanwhile to shake it up so as to obtain a thoroughly well-mixed broth. Cook in an uncovered vessel and on a slow fire for 20 minutes. When it is cooked, salt, and add the butter at the moment of serving.

Soya Bean Sprout Salad.

Select any vessel with holes in it for drainage and which can be covered. Have it large enough to allow for an increase in bulk of at least six times. Soak the beans overnight, place in the container, cover and set in a warm place. Flood with warm water at least four or five times daily during the sprouting period which will be from four to six days. The sprouts should be kept in a cool place just as any fresh vegetable. They may be served either row or cooked in salads, omelettes, stews, etc.

Served raw, these sprouts make a most excellent epicurean salad, much esteemed in the Far East. This dish is easy to produce and combines well with a mayonnaise or salad dressing.

STATISTICS.

The Tables that follow are chiefly for the purpose of showing the extent of our trade in soya compared with that of other countries and for indicating the fluctuations that take place in quantity and price. As will be seen Great Britain takes third place behind Germany and Denmark in the amount of beans and oil imported.

The British importation of soya beans showed a slight decrease, 158,976 tons in 1935 against 177,194 tons for 1934. On the other hand, imports of soya oil were higher at 33,556 tons compared with 10,772 tons for 1934.

The U.S.A. In the U.S.A. there was a considerable domestic shortage of cotton, oil and lard so that additional quantities of oilseeds and fats had to be imported and thus it comes that, during 1935, 6,361 tons of soya bean oil were bought from abroad. This indicates the extending uses in America for soya products.

Germany. Owing to various causes there was a distinct decrease in 1935 soya imports. In 1933 Germany took 1,152,460 tons of beans; in 1934 the figures dropped to 899,242 tons and in 1935 there was a still further reduction to 507,714 tons, though she still remains the leading bean importing country. One of the reasons for this diminished demand was because of negotiations with Norwegian whaling companies whereby an unsold balance of 115,000 tons of whale oil became available along with the produce of previous catches which brought Germany's whale oil purchases to 249,286 tons at favourable rates. But this cannot possibly continue in 1936 on the same scale as during 1935 and there will thus be a renewed demand for edible oils and fats.

Germany's export trade in soya oil is interesting for while in 1934 she exported 11,000 tons of it, in 1935 she only sent out 220 tons, which points to an increasing consumption of the oil within her own boundaries. It is much used in the making of margarine of which it forms the nutritional constituent.

Holland. Here was a good deal of activity in the crushing industry. The Dutch imports in 1935 of soya beans dropped to 79,135 tons against 130,518 tons for 1934 but they are still well over the 1933 figure, which was 39,244 tons. Holland's export of soya bean oil shows no important variation at 10,935 tons last year against 11,814 tons for 1934 and 11,835 tons in 1933.

Italy. Italy imports on an average 20,000 tons annually of soya beans.

Sweden. Imports into Sweden have for the past three years shown a steady improvement. In 1932 Sweden only took 9,007 tons of beans. In 1935 the figures rose to 100,855 tons.

Denmark. Denmark remains a good buyer. This country finds soya cattle feed eminently suitable for her production of bacon. Last year (1935) Danish soya oil mills produced 39,015 tons as compared to the output of British mills, viz. 23,847 tons.

Manchuria. As the Tables show, in 1935 the total export was 1,662,276 tons of soya beans compared with 2,289,905 tons for 1934. The reduction was chiefly reflected in the smaller amount taken by Germany. The prices paid to shippers were more satisfactory last year and in January of 1936 this improvement showed itself in the figure of £7 17s. 6d. per ton. The present Manchurian crop is estimated at 3,900,000 tons. This is about 300,000 tons more than the previous crop but it is reported that a

large quantity has been damaged by moisture so that the quantity of sound beans for export may not exceed last year's figure. The year 1935 finished with a firm market for soya oil and, in the early days of 1936, up to £22 10s. per ton was paid for all available soya oil.

Taken all round the prospects of the soya market for 1936 are very good. Manufacturers of soft soap are continuing their demands and as soya bean oil is also asked for as an edible oil it will not suffer in competition with whale oil.

The figures in these Tables are from a reliable source, as Messrs. Frank Fehr and Co. of Bury Street, London, who are a leading firm of oil seed, oil cake and oil importers, have kindly permitted me to quote from the volume of statistical information which they annually compile.

Shipments of Soya Beans from Dairen and Vladivostock per 1,000 Tons, Showing the Monthly Rise and Fall.

	1933			1934			1935		
January ..	86	143	230	154	72	227	109	71	181
February ..	85	84	170	163	44	208	134	60	195
March ..	103	94	197	148	23	172	47	69	116
April ..	99	110	209	159	57	216	26	65	91
May ..	126	71	197	94	63	157	48	44	93
June ..	125	38	163	118	63	182	74	61	135
July ..	141	187	159	114	52	167	94	49	143
August ..	125	9	134	100	15	115	88	27	115
September	133	7	140	96	26	128	86	33	119
October ..	153	14	167	114	37	151	77	54	131
November ..	126	29	155	209	64	273	66	51	117
December ..	211	65	276	232	64	297	150	70	220

Shipments of Soya Bean Oil from Dairen and Vladivostock (in Tons).

	1933			1934			1935		
Jan.	8,434	3,462	11,896	5,514	3,385	8,899	1,533	1,973	9,505
Feb.	4,348	4,904	9,252	2,881	3,461	6,342	3,608	2,364	5,972
March	2,021	5,048	7,069	3,462	1,525	4,987	4,758	1,419	6,177
April	781	3,711	4,492	9,789	1,419	11,208	6,051	1,538	7,589
May		1,991	1,991	9,490	960	10,450	7,325	1,277	8,602
June		1,501	1,501	10,162	23	10,185	7,043	907	7,950
July	2,212	517	2,729	4,987	85	5,072	5,777	2,199	7,976
Aug.	1,800	2,180	3,980	483	692	1,175	4,537	1,562	6,099
Sept.	2,628	1,504	4,132	351	586	937	3,712	3,127	6,839
Oct.	1,116	700	1,816	3,807	1,046	4,853	5,563	640	6,203
Nov.	3,566	1,101	4,667	5,861	773	6,634	3,427	876	4,303
Dec.	5,519	1,946	7,465	8,071	1,130	9,201	5,161	1,668	6,829

Soya Beans and Oil: Average Prices during Past few Years.

	1914			1929			1932			1933			1934			1935		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Soya beans	7	15	0	11	5	0	7	5	0	6	7	7	5	16	3	7	0	0
oil	26	10	0	30	2	6	18	12	6	17	10	0	14	0	0	21	0	0
meal	6	2	6	—			9	7	6	7	7	6	6	13	9	17	6	

This Table shows the fluctuations in price and may be useful in forming an opinion about future developments.

The Three Chief Soya Bean Producing Countries.

	1933	1934	1935
	Tons	Tons	Tons
Manchuria ..	4,601,000	3,599,000	3,900,000
U.S.A. ..	200,384	457,768	990,924
Japan ..	An average annual crop of 450,000 tons		

The Soya Oil Trade Production—Showing the Amounts Dealt with in Oil Mills in the Respective Countries.

	1933	1934	1935
	Tons		
China (export only) ..	62,990	79,943	84,044
Japan	35,000	35,000	45,000
Great Britain	23,623	26,579	23,847
Germany	172,869	134,886	76,157
Holland	5,886	19,577	11,870
Denmark	35,202	40,917	39,015
Sweden	8,682	13,986	15,128

Imports of Soya Beans to Europe.

	1930	1931	1932	1933	1934	1935
	Tons	Tons	Tons	Tons	Tons	Tons
Germany	874,790	998,595	1,168,300	1,152,466	899,242	507,714
Denmark	172,264	238,042	228,864	234,683	272,875	260,101
Great Britain	105,559	110,194	158,938	157,489	177,194	158,979
Sweden	49,132	31,206	9,007	57,883	93,883	100,855
Holland	19,231	32,183	41,684	39,244	130,518	79,135

Imports of Soya Bean Oil into Great Britain.

1930	1931	1932	1933	1934	1935
Tons	Tons	Tons	Tons	Tons	Tons
25,299	28,666	27,343	19,806	10,772	33,556

Imports of Soya Bean Cake and Meal into Germany.

1932	1933	1934	1935
Tons	Tons	Tons	Tons
119,060	94,484	13,048	30,268

INDIA.

Though the soya bean is grown without difficulty in India, especially in the northern half, most of what is used is imported from China, Japan and Manchuria. It is an ideal food for the Indian people, the majority of whom are vegetarians and poor. The fact of its being so comparatively unknown in India is due to the fact that each race, community and family has their own age-old special dietary from which they rarely, if ever, vary. Mr. D. D. Kanga of Gujerat College, Ahmedabad, writing in *The Vegetarian News* of February, 1936, said:—

> "If Mother India wishes to have a race of strong, healthy and virile sons and daughters she must see that soya bean is grown most extensively in the different parts of the country and that it becomes a household word in every home and is included in the dietary of every family."

and in a recent issue of the *Indian Humanitarian* there is the following note showing the awakening interest in this matter:—

> "It is gratifying to note that experiments carried out in Sindh, Poona and other places show that the soya bean can be successfully grown in our country. The Saurastra Seva Samiti, Ranpur, Kathiawad, is doing good solid work in popularizing and distributing soya beans among the cultivators of its own province. It is equally gratifying to note that Baroda State has also begun the cultivation of the soya bean in its territories."

Public Institutions like the Sir Ratan Tata Industrial Home and the Bengali Girls' School now include the bean in their dietary, and its use in a number of table preparations was introduced to visitors at the soya bean restaurant in a fête held last year in Bombay.

Mr. Kanga in his article said:—

> "Hardly one person in a thousand even amongst our educated people has heard about this important foodstuff, much less seen or handled it."

In advocating the necessity of more nitrogenous food for the Indian people, to improve their power against disease, output of work and power of endurance, he shows how the main food materials from which vegetarian India could expect to get these nutritious constituents are milk and milk products like curd and ghee (clarified butter) so that it becomes important that these should be available in sufficient quantities and in pure unadulterated form. But there are 338,000,000 people in India and not enough ghee and milk for all of them, and even if there were sufficient, the majority of the people are too poor to buy either of these. The following table shows the relative value of leading Indian food materials .The values are given for one ounce of the foodstuff. (One ounce equals 28·3 grammes).

	Protein in g	Fat	Carbohydrates in grm.	Calories per oz.	Vitamins A	B	C	D
Lean mutton	5·97	1·98		43	V.L.	+	V.L.	+
Freshwater fish	5·50	1·15		32		+		
Chicken ..	6·74	0·38		30	+			
	3·79	2·97		42	++	+++		+
Ghee		23·10		208	+++			+
Buffalo's milk	1·35	2·18	1·24	30	+++	+	+	+
Wheat (atta)	3·90	0·54	20·35	102	+	++	O	
Peas (dried) ..	1·85	0·17	4·75	28	+	++	O	
Soya bean ..	9·60	4·70	9·50	119	+	++		+

Major-General Sir Robert Carrison, I.M.S. Director of Nutritional Research in India was the first to draw the attention of the Indian people to the importance of the bean as a cheap and nutritious foodstuff. There are indications that his advice is receiving a spreading amount of attention.

In the Annual Report, for 1935, of the Imperial Institute there occurs the following paragraph:—

> "*Soya Beans.*—In connection with an investigation into the possibilities of creating a market in the United Kingdom for Indian soya beans, three varieties of soya beans—viz.: Pusa White, Manchurian and Punjab White—were received through the Indian Trade Commissioner and were found to contain

respectively 16·2, 18·8 and 15·6 per cent. of oil. The oils were on the whole of normal character and the residual meals contained satisfactory amounts of protein. All three varieties would be readily saleable in the United Kingdom, the Manchurian type commanding a slightly higher price than the others on account of its higher oil content."

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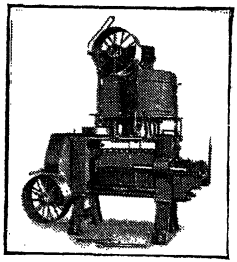

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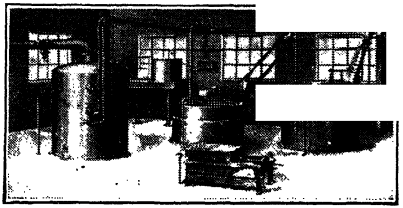

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